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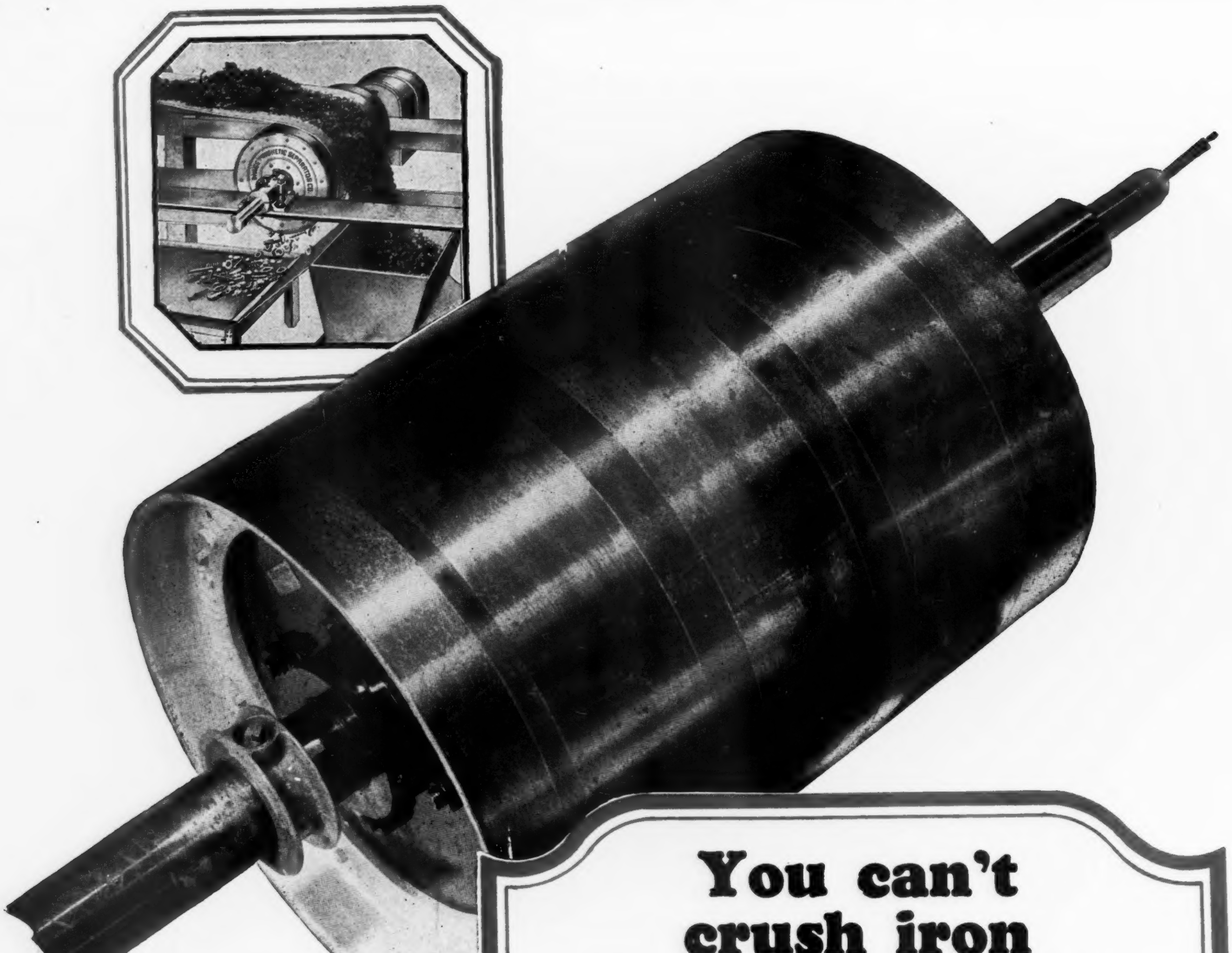

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Pit and Quarry

Vol. 14 CHICAGO, ILL., MAY 11, 1927 No. 3

TAKING THE GAMBLE OUT OF BUSINESS

By Charles F. Abbott

A FEW days ago, just before I began the preparation of this article, I was looking through a copy of one of the leading publications edited in the interests of the advertising profession. What I found in that magazine gives a cross-section of a changing industrial situation that is of startling significance. On page one of the publication was an announcement that an advertising campaign on behalf of the State of Iowa would soon be undertaken to tell the East about Iowa's products. Page two contained an article describing the plans of the ice manufacturers to resist the encroachment of electric refrigerators upon their market. On page seven was another announcement of a projected advertising campaign. All the Norwegian packers of herrings, sardines, and other fishes, it was stated, were about to begin a co-operative campaign in this country. Finally, there was an article emphasizing the success of the advertising campaign of the Copper and Brass Research Association.

Here is no picture of a multitude of individual concerns competing with each other, such as we would have seen twenty years ago. The picture we have is of industries competing with industries, of states competing with states, of the industries of a whole nation competing with the industries of other nations. What has brought about the competitive condition we have with us in the third decade of the Twentieth Century? It is not hard to put our fingers on the answer.

Problems of finance and production have been practically solved, but with their solution we have been presented with a third problem. We are finding it more and more difficult to find new markets to consume our increased production. We are finding it steadily more difficult to hold the markets we have.

Pretty nearly every industry once had what it considered its natural market. Who, for instance, would have dreamed that rayon and silk would wrest away huge sections from the domain of King Cotton, that the prosperity of the leather industry would be seriously affected by the use of the hundred and one substitutes for leather that are now offered for sale?

Yet these things have happened. The prosperity, the very existence, of every industry is dependent upon holding and broadening its market, and upon developing new markets—both in the face of invasion by substitute materials produced by other industries. The prosperity of whole sections of the country, of whole nations, our own included, is dependent upon a similar struggle for markets.

We have an idea that we are a successful business people. So does the rest of the world. But the bitter truth is that we are not making such a wonderful showing in meeting the situation created by the new competition. Satisfactory profits are being made by a few well managed organizations, while thousands flounder around in the dark, hoping that luck will break for them. It seldom does.

According to J. George Frederick, President of the Business Bourse, forty-three per cent of all our corporations show a deficit each year. The net profit, before taxes, of all American corporations is only five and six-tenths per cent. The dividends paid are only seven-tenths of one per cent on the capitalization of all the country's corporations. How long are we going to remain complacent under such conditions? The competition in which we are engaged is a battle of the giants. Complacency has no place in such a struggle. Whether we like it or not, we are confronted with a condition that makes the old competition between units of the same industry pale into insignificance. Failure to-day entails more wide-spread disaster than ever before. The opportunities for success on a vast scale are more numerous than they have ever been in the history of the world.

If we are to grasp these opportunities and bring them to fruition, it is more than ever essential that we see conditions as they exist, and guard against every adverse factor. The stakes are so enormous that a set-back may mean the ruin of an entire industry. Nothing must be left to chance. Business must become, so far as possible, an exact science. We must stop floundering in the dark.

Commercial research offers us the best means of accomplishing this aim. Research, as applied to production, is not a new development. Already it has done much to exclude the element of luck that once so greatly influenced the manufacture of many commodities.

Production research plays a leading part in American business. Referring again to figures compiled by J. George Frederick, one twenty-five-hundredth part of our corporations make nearly a third of the total profit. Almost every one of these 162 highly profitable corporations operates a research department. Almost all of the remaining 417,259 do not. But, although research has taken the gamble out of the production of most commodities, the gamble is still strongly entrenched when it comes to the selling end of the business. Here too, however, chance can be largely done away with through proper research.

Improvement in methods of production will naturally remain one of the chief objectives. It is to the advantage of every producer to turn out the best possible article at the least cost. Further, any achievement in this line usually reacts to the benefit of the consumer through a reduction in the price he has to pay. The commercial research of the future will have to be devoted to an increasing extent to the market—to increasing the buyer's receptivity to the product. The needs, desires, whims, and benefit of the consumer must be held always in view. As a consequence, there are two main paths that commercial research will have to follow in the years ahead.

First of all, a great deal of study will have to be given to the use of the commodity. There is no progressive manufacturer who does not realize that his responsibility ends only when his product is placed in proper use. Even though the product may be entirely out of his hands, the manufacturer's future sales will be adversely affected if the consumer does not know how to use the product; or if, because of certain remediable factors, the consumer is unable to realize upon its full potentialities.

Secondly, attention must be devoted to discovering new and broader uses. As long as natural markets existed, it was all very well to concentrate upon supplying those markets. But we can never hope to see that condition return. With natural markets no longer to be found, when every market is subject to encroachment by substitute materials, the manufacturer's best assurance of continued progress lies in the penetration of new markets opened up to him by the development of new uses for his commodity, or by alterations in it to better meet the demand.

Any attempt to influence the use of a commodity, to invade a hitherto closed market, or to open up a previously undiscovered one, necessarily demands the expenditure of large sums of money—sums too big to gamble with. Here, in particular, the element of chance must be reduced to an absolute minimum.

Already research has shown what it can do in these directions. The record is an impressive one. It remains only for industry as a whole to take advantage of the possibilities it offers. Market research must be lifted to a position equal to that held by research devoted to production processes. Research of the nature referred to, as conducted up to the present time, may be divided into two classes—research conducted by individual organizations, and co-operative research organized and financed by the whole industry for the benefit of all its members. Take the Bakelite Corporation. Research has enabled this company to place its products on the market as substitute for wood, glass, amber, celluloid, fibre, rubber, shellac, gelatin, horn, ivory, metal, paper, porcelain, rawhide, and vegetable ivory. There are a score of uses for the product to-day as contrasted with its few uses only a little while ago.

It is obvious that the prosperity of any individual organization is, in the final analysis, based upon the success of the industry as a whole. Research conducted by an individual organization helps that particular unit, but something more is needed when industry is marshaled against industry for what it considers its legitimate share of the consumer's dollar.

What can one concern do, or individual research accomplish, in the face of competition from an entire industry? There is no organization in the United States big enough to adequately develop a new market. There is no one concern big enough to assure the proper use of its product throughout the country. There are thousands of concerns that are not large enough to carry on any effective market research, that are not powerful enough to even begin to develop a new market, and that cannot in any way assure the use of their product to the limit of its potentialities. What is the answer? Must all that I have said about the future of commercial research remain in the realm of theory just because the problem is too big for any one organization to solve? Not at all. Industrial co-operation provides an adequate means to meet the situation as it exists. To large concern and small, co-operation offers a method by which commercial research can be utilized to the full extent of its tremendous possibilities.

No man can hope to control the winds and currents that disturb and change the markets of the world. It is, nevertheless, true that the more he bases his plans on such accurate knowledge as market research can give him, the more he limits the part played by luck, chance, or whatever else you want to call those apparently unpredictable factors that have buried so many concerns in the graveyards of industry. When we have devoted as much attention to taking the gamble out of the selling end of business as we have to eliminating it from the production end, then, and only then, will industry in this country be established on the sound foundation that is essential to continued progress.

PROGRESSIVE CANADIAN LIME COMPANY KNOWS HOW TO SOLVE PROBLEMS

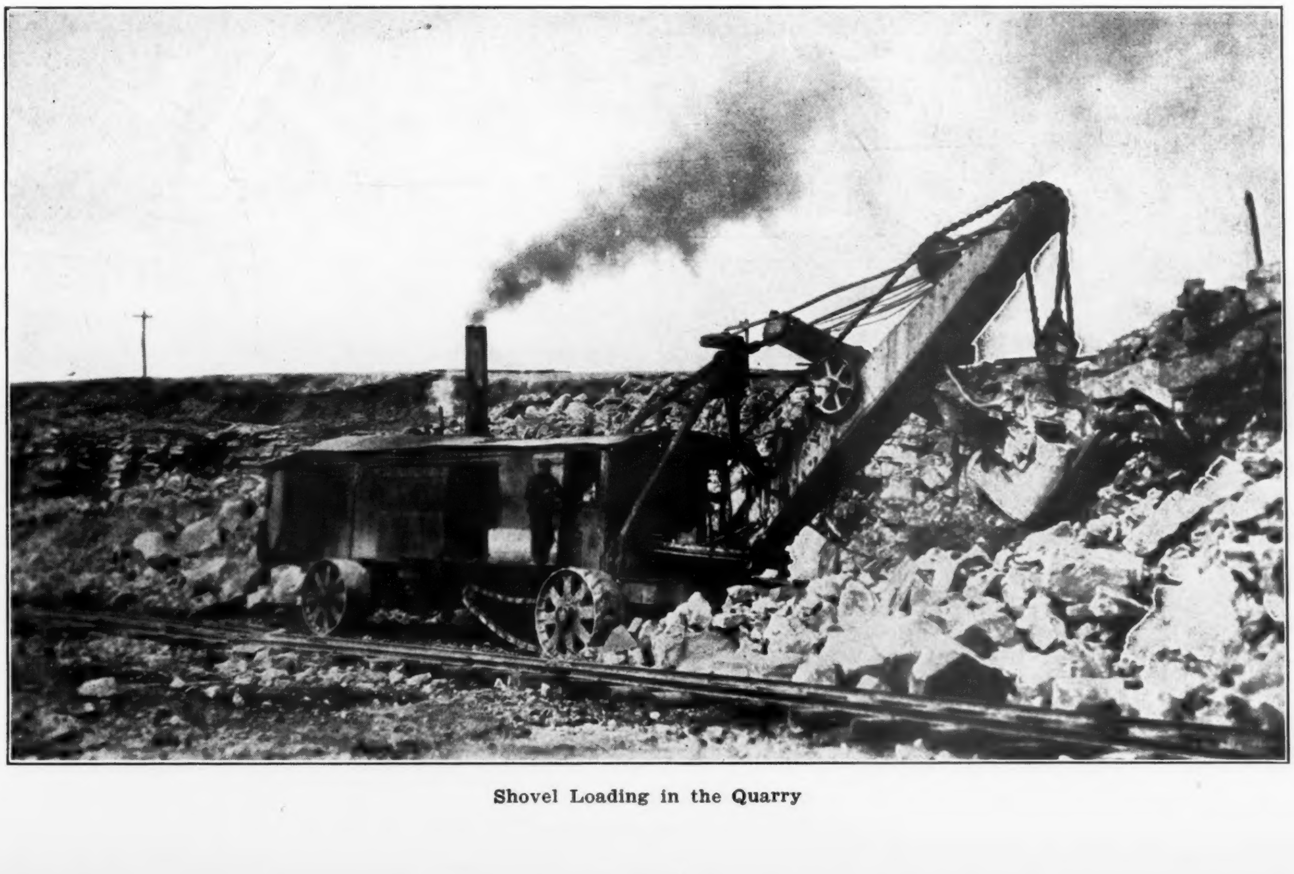
BETWEEN the towns of Ingersoll and Woodstock in the Thames Valley, Oxford County, Province of Ontario, Canada, is located the plant of the Beachville White Lime Company. The valley at this point is approximately one-half mile wide at the bottom and slopes rise gently to an elevation of three or four hundred feet to an even level, making open pit quarrying possible only in a comparatively small area. The valley drains the famous Oxford farming district, through which runs the Thames River, having its source about fifteen miles east of this point, and although it is a very insignificant stream during ten months of the year, it becomes a veritable torrent during March and April. This necessitates the upkeep of dykes and dams to keep the river out of the quarry.

The plant is ideally situated in the center of the deposit of very high calcium limestone bearing an analysis of 98.5 per cent calcium carbonate, low in silica and sulphur. The good zone is approximately three-fourths of a mile wide, gradually tapering out on either side of the plant to a conglomerate formation. There is an average overburden of some six or seven feet in the quarrying zone. A portion of this is used in making and repairing the dykes and dams. The remainder is loaded into six yard standard gauge Kilbourne and Jacobs cars by an Erie ¾-yard shovel and hauled by two Montreal 20-ton locomotives to the disposal dump down the valley.

The drilling is done by two Sanderson Cyclone number 14 drills, boring a 6-inch blast hole. In addition a small home-made rig is used for cleaning out holes just prior to a shot. This is necessary as cuttings have a tendency to work through from other strata. A 35-foot bench is being worked at the present time with another 40-foot left, awaiting future needs. Holes are drilled 12 feet back from the face on 12-foot centers. Cordeau Bickford fuse is used entirely for the large shots which run as high as 180 holes at a blast. The Canadian Explosives, Limited, 4 by 16 inch stock, 40 per cent dynamite is used exclusively.

Broken rock is loaded in the quarry into Kilbourne and Jacobs 6-yard standard gauge cars by a Marion number 61 steam shovel. This shovel has been recently mounted on traction wheels which have greatly increased the efficiency of the shovel and have eliminated moving delay, almost entirely. The quarry cars are hauled to the foot of the tramway by 8-ton Brookville gasoline locomotives. The cars are hauled up a 20 degree incline by a Marsh Engineering Works hoist 48 inches in diameter direct connected to a General Electric 75 h. p. slip ring motor. An air lift is used to dump the cars into a Traylor jaw crusher with openings 48 by 60 inches. A 200 h. p. General Electric slip ring motor drives the crusher using a 24 inch Gutta Percha belt without a belt tightener.

The stone falls from the jaws of the crusher into a hopper of about 15 tons capacity. From this it is fed to a 30 inch belt conveyor by a 36 inch



Shovel Loading in the Quarry

Close-up View of the Well Drill

steel apron feeder, manufactured locally. The belt is inclined at an angle of 15 degrees, discharging into a bin over a number 8 Kennedy gyratory crusher set at a maximum size of 3 inches. The stone as it falls from the conveyor lands on a set of 1¼ inch bars spaced 1½ inches apart clear opening set at an angle of 35 degrees. The large pieces falling on the bars vibrate and keep it fairly clean. The fines scalped out are by-passed direct to a 36 inch belt conveyor. The oversize falls into a storage bin of some 200 tons storage capacity, built around the Kennedy crusher. After passing the number 8 crusher the stone is conveyed by the 36 inch belt conveyor set at a pitch of 14 degrees to a Kennedy rotary screen 72 inches in diameter. The screen is made up of four five-foot sections having perforations ¾, 2, and 3 inches, respectively. Stone passing through these screens drop into their respective storage bins which are built of concrete and heavy timber construction. The rejects from this screen fall into a bin and feed to a 48 inch Symons disc crusher. This falls on a 26 foot belt conveyor which returns it to the 36 inch conveyor which in turn delivers to the rotary screen. It is not necessary to operate the Symons crusher more than an hour per day. This can be done after the other machinery is shut down for the day, thus saving power costs.

One-man rubble stone is carefully selected by hand from the broken stone in the quarry, loaded into skips and hoisted by a derrick direct to flat cars. Two quarries are being operated at the present time. The second is used to supply stone for the lime kilns, which are four in number. The stone is selected and loaded by hand into skips on a piece

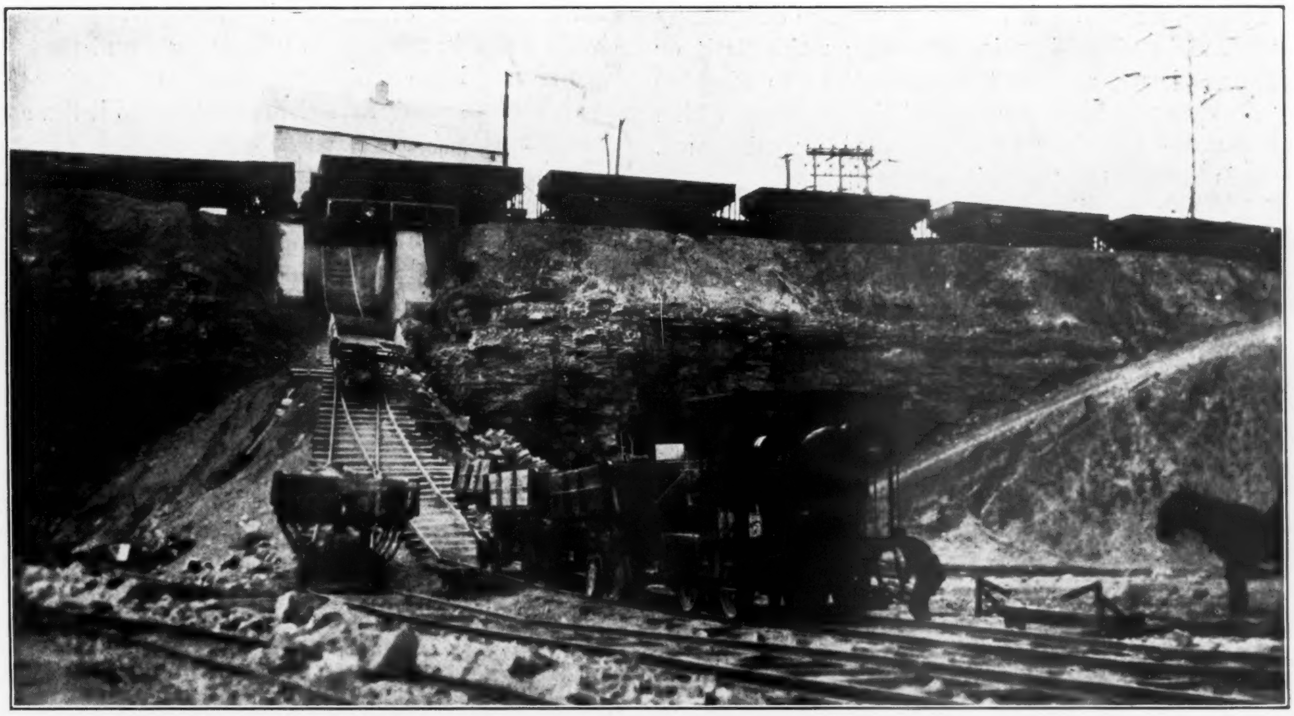
Showing Part of the Quarry and the Track System work basis. The two ton skips are hoisted direct from the quarry by a square derrick to the charging hopper of the kiln. The kilns are old shaft type, three being fired with coal and one with cordwood. A portion of the lime which has a very high calcium content is loaded directly into box cars in lump form. The remainder goes to the McGann hydrating plant, which has recently been added.

The hydrator is of the Schulthess type, manufactured and installed by the McGann Manufacturing Company, and has a capacity of three tons an hour. The hydrate is elevated to a McGann air separator and finished material falls into a fifty ton storage bin. The trailings return, by a screen conveyor, to a beater mill and then back to the hydrator. The product is put up in 50-lb. paper sacks by an automatic Bates bagging machine.

The output of the stone quarry is 1,700 tons daily and on account of the market demand it is necessary to continually operate the year round. The stone from dust to one-man size finds a ready market in the industries, which include cement, iron and steel foundries, carbide, where it is converted into cyanamid, glass, paper, sugar manufacture, etc. The lime, both lump and hydrate, is supplied for building, tanning, glue manufacture, chemical plants, sand lime brick plants, etc.

The plant is on the London Division main line of the Canadian National Railways. Power is purchased from the Hydro Electric Commission of Ontario and is generated at Niagara Falls, 100 miles away. The charges are based on the highest five minute peak at the rate of $30 per h. p. per year. The service has always been excellent. The main office of the Beachville White Lime Company is in Beachville, Ontario, and Mr. C. E. Downing is general manager.

Incline From Quarry to Plant



Showing the Method of Handling Cars at Incline

ROLE OF LIME IN TANNING

By George D. McLaughlin*

THE beginning of the use of lime in connection with the tanning of animal skin dates back to very ancient times, so ancient, indeed, that we have no reliable knowledge of even its approximate date. The improvements which science has brought about in many manufacturing processes have caused the partial or complete replacement of many time-honored materials. This is not true of the use of lime in tanning, however, which is greater today than ten years ago.

If we examine a stained section of skin under the microscope we readily see that it is made up of three general layers—the epidermis, corium, and flesh or adipose tissue. (The histologist splits these again into subdivisions, but they are not important for this discussion.) The epidermis represents probably 2 per cent of the skin thickness. The corium, which comprises the bulk of the skin, is the leather-forming substance. The epidermis drips down into the corium, forming a pocket or follicle in which the hair is embedded and held. Strands of elastic fibers run through the upper and lower parts of the corium, and the upper portion contains fat and sweat glands as well as the muscles which motivate the erection of hairs.

The whole skin is composed of water, salts, proteins, fats, and carbohydrate. Fortunately for the tanner, however, the three structural divisions are quite different in their composition. The epidermis is composed largely of the protein keratin, while the corium is mainly the protein collagen. Keratin is rapidly dissolved or decomposed by alkalies, whereas collagen is digested only slowly.

The object of the tanner is to remove completely both hair and epidermis, as well as the flesh or adipose tissue, and at the same time to dissolve or destroy the least amount of the callagen which composes the corium or leather-making substance. This is termed the "unhairing" process.

The flesh or adipose tissue may be removed mechanically even in the absence of any chemical treatment, but the epidermis must be decomposed before it and the hair can be removed. Bringing about the proper decomposition is one of the most important steps in tanning. This decomposition ensues when the skin is soaked in solutions of alkalies or acids or sulfides, or when proteolytic bacteria are allowed to act on its surface. The use of acids has never proved satisfactory, for several reasons, one of which is that part of the skin must be saponified. Bacterial digestion is very difficult to control. There are now being marketed enzyme preparations which unhair, but their use is still limited. Most unhairing is accomplished with an alkali, either alone or mixed with sodium or arsenic sulfide. This alkali is a saturated solution of calcium hydroxide, although any soluble alkali will bring about unhairing.

Lime is favored not merely because of its cheapness. It has a limited solubility and a saturated lime solution has a pH value of about 12.5. Therefore, the tanner may make up a vat full of lime solution and add an excess of undissolved lime, knowing that the solution's alkalinity cannot exceed pH 12.5 (at constant temperature) and that as lime is removed by the skins from the solution that excess lime will dissolve and maintain saturation. In other words, he has a practically automatic, foolproof process. Lime does not digest the collagenous material of the skin so greatly as do sodium and potassium hydroxides. Lime sponifies a portion of the fat in the skin. A lime soap is of a curdy nature, holding little water. It is important that the fat in the hair follicle be partially saponified so that the alkaline solution may freely penetrate the follicle and digest the keratinous material holding the hair. The curdy nature of the lime soap formed permits this penetration better than the jelly-like sodium or potassium soaps that result when these alkalies are used.

In view of our lack of fundamental knowledge of skin proteins and their behavior towards electrolytes, it is difficult to lay down strict standards or specifications for lime quality for unhairing. It cannot be doubted, however, that a high CaO content is desirable, that even a small amount of iron is objectionable, that high megnesium content is either harmful or wasteful (since it seems practically inert in respect to unhairing), and that the lime should have a high "suspension factor"—that is, the excess undissolved lime added to a lime vat should settle downwards slowly.

Probably even more important in the unhairing process is the effect of the lime upon the molecular character of the skin proteins, but this phase of the subject has been purposely avoided in this discussion. It is known that the chemical action of the lime upon the skin greatly affects the behavior of the skin in its combination with tanning materials, both organic and inorganic.

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*Presented before the Symposium on Lime at Richmond, Virginia, on April 13.

Unsintered Hydraulic Mortar

Clay or some similar substance is intimately mixed with burned, dry or slaked lime and ground. The mixture is burned below the sintering temperature and the product of the burning ground as a cement. Oil shale may be used as fuel. (Rekord—Zement-Industrie and Oskar Teteus.—German Patent 440,795.)

CONSUMER, MARKET, LIME BUSINESS AND THE CHEMICAL INDUSTRY

By Charles Warner*

THIS symposium represents a noteworthy effort to bring to light more information and likewise to disclose the extended lack of information and the misinformation bearing upon this cheapest alkaline base with its hundred-odd applications in the chemical industries. Even with the awakened interest and extensive research efforts of the past few years, bearing upon lime in its ramified uses, few seem to see that we are dealing with a situation involving thousands of possible combinations, though most of us realize that we are only just beginning to learn some of the really important and vital characteristics of lime which so considerably influence its satisfactory and economical use.

There was a time when most industries thought they had learned all that it was necessary to learn about lime for their particular purposes when they had secured the chemical analysis and the price. Today we are just beginning to appreciate that there are many physical variations in the different limes and their products due to differences in the structure of the original rock, in the methods of burning, and in the manner of its slaking or hydration, which will cause wide variations in its adaptability to the many industries now using it as a raw material. The same lime rock, sized and burned in two different ways, both methods being standard practices in various plants in this country, has shown a difference of 40 per cent in the effectiveness of its use in a specific industry, and this in spite of the fact that the high-efficiency lime showed by chemical analysis 2 per cent less available oxides.

In many industries lime has not received the study it should have to determine the particular characteristics needed for maximum benefit. This has probably been due to its cheapness, which has doubtless caused many of the consumers to frown upon its importance and to ignore its variations. It is hoped that this symposium will arouse the technical men and the executives in the lime industry and many of the chemical industries using lime to the importance of further investigation, and above all to the need of practical and friendly cooperation between the modern lime manufacturer with his technical staff and those responsible for improving the manufacture and control of practices in the industries using lime.

Lime manufacturing in its simplest form merely involves quarrying lime rock from general strata, passing this material in its crude form through an oven which will stand temperatures up to about 2,300 degrees Fahr. and then shoveling this product into a car for shipment.

Lime manufacturing as perfected in some modern plants involves:

(1) Careful selection of the rock strata that appear in every limestone deposit in order to use for burning only such grades as are specifically suited for the known chemical, building, or agricultural uses for which the lime is to be sold.

(2) Proper sizing of the rock to give uniformity of burning in the particular type of kiln being used and under the particular method of burning employed.

(3) Maintenance of steady heat application for uniform and understood periods in order to produce that quality of burnt lime required for the particular trade, and of as nearly uniform quality as modern experience provides in plant control.

(4) Maintenance of those conditions for hydration which are found to produce the desired characteristics in each lime.

(5) Thorough and continuous chemical and physical control of all these steps by skilled laboratory supervision.

Lime manufacturing has become a highly specialized chemical industry, though many do not yet recognize this fact. The methods still pursued in many quarters where the highest grade of chemical limes should be manufactured, and the lack of understanding and specifications on the part of many users give evidence of this.

The marketing side of the lime business also deserves much more thought. The competent lime manufacturer, through his sales and technical forces, must become thoroughly familiar with the processes employed in the industries that he is endeavoring to serve, so that he can determine the chemical and physical properties desired for the lime in each case. This knowledge of the market is gained only after years of study, but manufacturers who have vision realize that this kind of marketing is fundamental to the uniform production of the most effective grades of lime.

Lime-burning plants, including raw material deposits, can be developed at capital cost ranging from $1,000 to $7,000 per ton of daily output. This is a very wide variation, and yet this fact has such a large bearing upon the market situation and the consumer's problems, that it should be brought out in this general statement.

As has been previously stated, lime manufacturing in its rudimentary form is a very simple proposition, an enterprise which can be started on

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*Presented before the Symposium on Lime at Richmond, April 13th.

a small scale, at small capital outlay, and by inexperienced people, without engineering or chemical appreciation of their problem. A small deposit of limestone on a barren farm often leads to the building of a small kiln or two. Such lime can be used satisfactorily for some of the agricultural and local building purposes, but for most of the chemical industries, where uniform and high-grade material is usually essential, it is a constant menace.

There is no doubt that such competition by its influence on the general plane of market prices has hindered the efforts of the lime industry to supply a high quality of products in the most reliable way and therefore retarded its growth. It has been only within a very few years that a few of the lime manufacturers, inspired partly by the initial research efforts of the National Lime Association and some prominent consumers of lime, have endeavored to raise the quality and service requirements, in spite of the moderate yield on the capital required to construct a modern plant of large capacity. Such organizations can solve their business and financial problem only by a large production in order to take care of the extra costs of stone selection, storage service, and extended chemical and physical control of all operations. As an additional expense, the modern chemical lime enterprise must endeavor to work out its part of the thousands of combinations by the closest possible technical cooperation with the lime-using industries. This is scientific marketing in its American form. When the technical men in the lime industry have learned the effect on the physical characteristics of the finished product, of the various changes that they can control in the selection of burning rock, and the various methods of slaking or hydrating, they are in position to cooperate with men of similar experience and training in the consuming industry in working out specific applications. Such intelligent cooperation is now beginning to develop between producer and consumer and it should be encouraged to the utmost.

It is fully appreciated that some chemical industries, believing that they have processes that are valuable, in part because of their secrecy are loath to cooperate in this way for fear that information of successful methods will be carried to the plants of competitors. In many cases where doors have finally been opened to the lime manufacturer's chemical experts, it has been demonstrated that the lime men, through broad experience and acquaintance with the numerous methods of manufacturing and use, have been of distinct help in further improving the lime and its application to specific processes. It is surprising how many manufacturers in all industries, including lime, still believe that they have some improvement or scheme in their processes that is better than their competitors' when nine times out of ten their competitors as a whole have many more successful ideas than the secretive one.

In this age the open door is the real way to build up American industries and without doubt our American industrial supremacy in many lines is due to the broad cooperation that has developed in so many places, so as to utilize the best thought, and all the thoughts, in the development of every enterprise.

A lime salesman who can bring the technical men of his own company into contact with the technical men of a consumer often performs his greatest service both to the consumer and the producer. A purchasing agent or an executive of a consumer who blocks the way to such technical help may be preventing an improvement in either the quality or costs of the finished products.

As the manufacture of special grades of chemical lime products develops, in order that they may have the maximum desirable characteristics for each of the refractories, glass-making, tanning, soap and sugar manufacture, water purification, and other processes too numerous to mention, lime plants will become specialists and operate for these distinct uses. The building and agricultural trades should be supplied by such lime plants only for by-product and off-grade distribution. Unquestionably, the trend in lime manufacture is, and should be, in this direction, since the industrial consumption of lime now approximates one-half of the total use of lime in the United States. Chemical lime should therefore be considered by plants which are qualified to manufacture it properly, as their primary product, and every production policy should follow this principle.

There is too great a tendency today in many lime plants to manufacture building lime as a primary product and to treat the chemical grades as a by-product. Of course, consumers who have considered price first in placing their orders, cannot expect so much in the way of consideration on the quality and service factors. This practice of purchasing largely on a price basis must be due to a lack of knowledge of the variation in efficiency and quality of the different kinds of lime on the market at this time. It is therefore urged that purchasing departments acquire as complete a knowledge as possible of the limes available for any particular consumer's plant, and sufficiently clear specifications for economy and quality in the finished products to enable them to buy on economic standards and not on price standards. Almost all American industry is trending this way, and properly so.

Both the producers and users of lime should become acquainted as rapidly as possible with their particular requirements and the inherent possibilities in lime itself. When this has been accomplished in each industrial use, we shall have made a decided advance in the intelligent and economical use of lime so that reasonable continuation of high-class results can be secured.

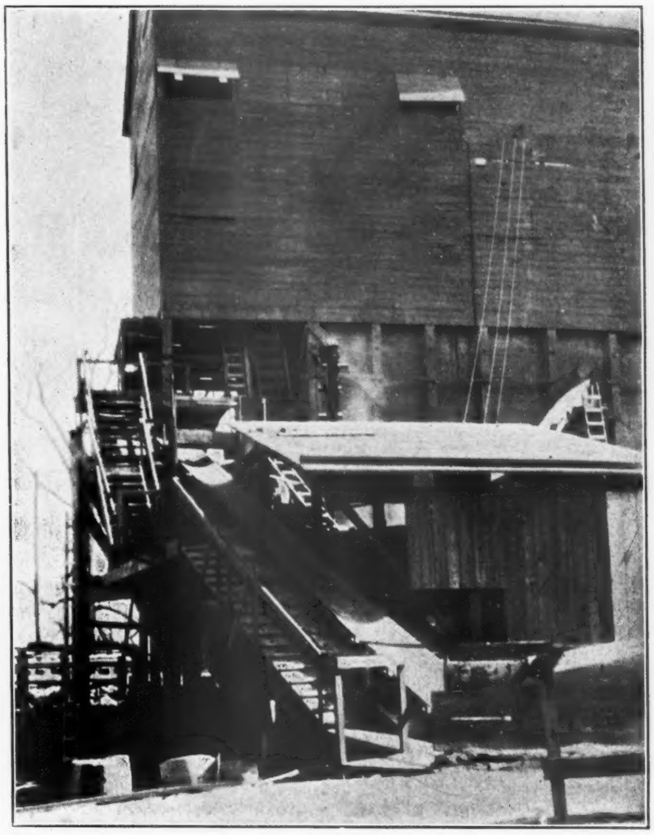
DETAILS AND EFFICIENCY ASSOCIATED IN THIS TRAP ROCK OPERATION

By F. A. Westbrook

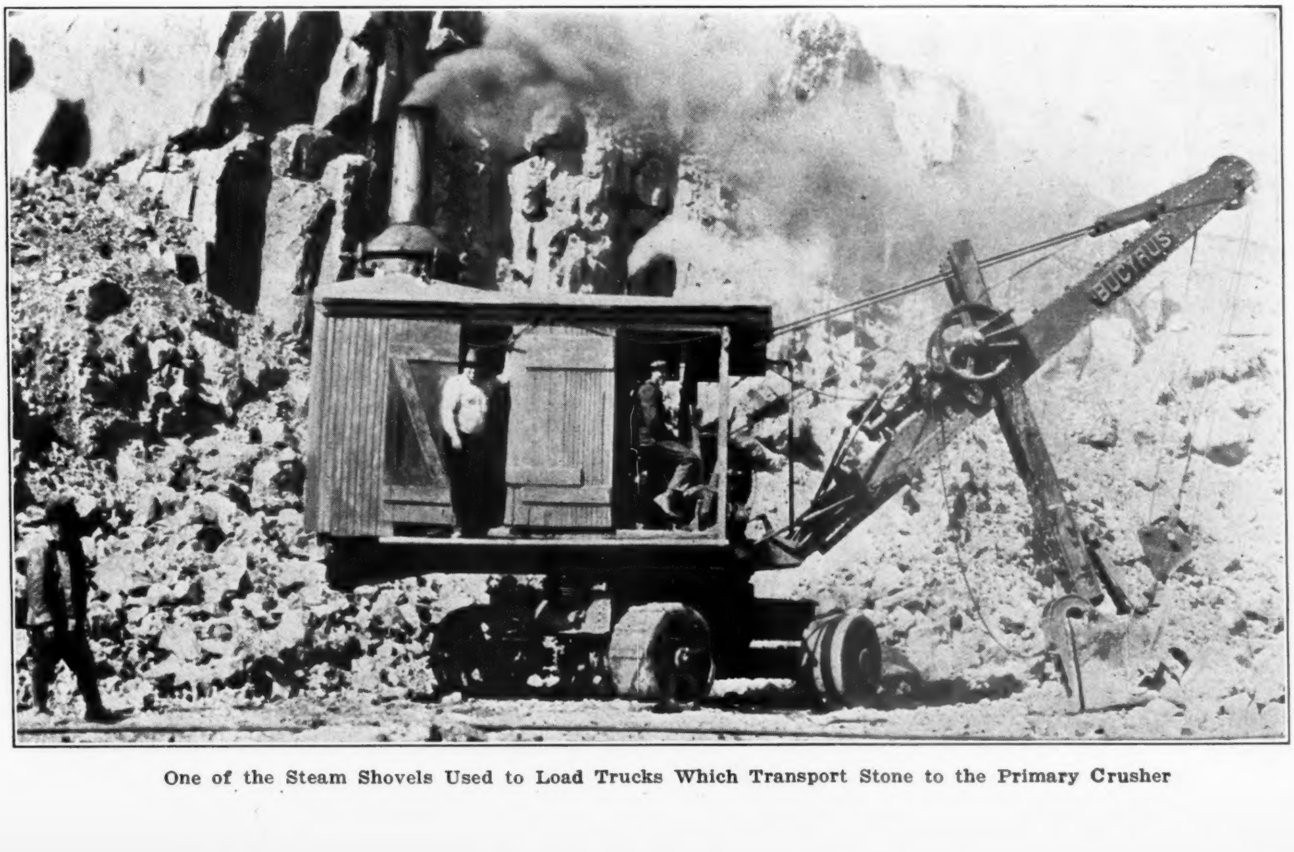
DOUBTLESS it is axiomatic that careful attention to details is the price of efficient operation. At the same time owners of industrial enterprises often buy the best obtainable machinery, provide excellent buildings, organize first class advertising and selling departments and then neglect to secure the services of a superintendent who will run the plant so as to get the most out of the equipment.

The most striking feature about the trap rock operation of the Great Notch Corporation, at Great Notch, New Jersey, is the excellent service given by the machinery. For instance there has not been a hot motor bearing at this plant in three years and the cost of maintaining one of the Company's Autocar trucks, used to haul stone from the shovel at the breast to the primary crusher, has only been approximately $304.00 for three years. Of course this record would not have been possible without proper care, for although this car is capable of giving excellent service it cannot do so if neglected. Undoubtedly much of this low cost and efficiency is due to the superintendent, Mr. Britt, who really superintends.

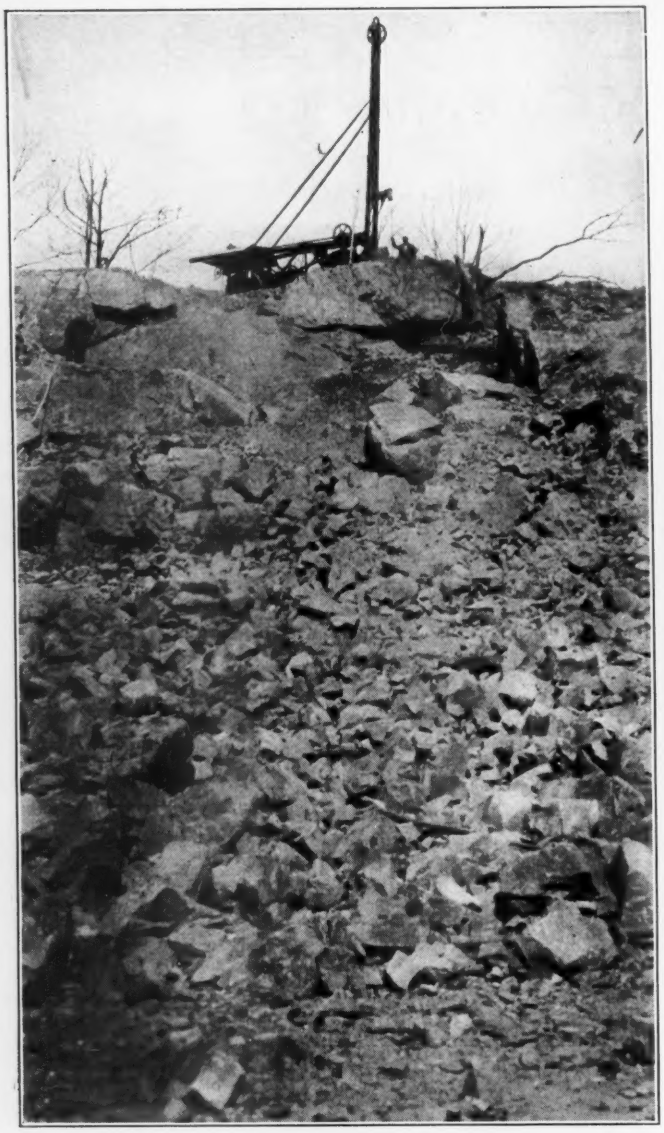
The face of the quarry is about 65 feet high. Two Armstrong electric well drills are used for the main drilling. The holes are drilled about 16 feet back from the face, 18 feet apart and to a point



Conveyor From Primary Crusher to Secondary Crusher and Elevator From Latter to Screen



One of the Steam Shovels Used to Load Trucks Which Transport Stone to the Primary Crusher



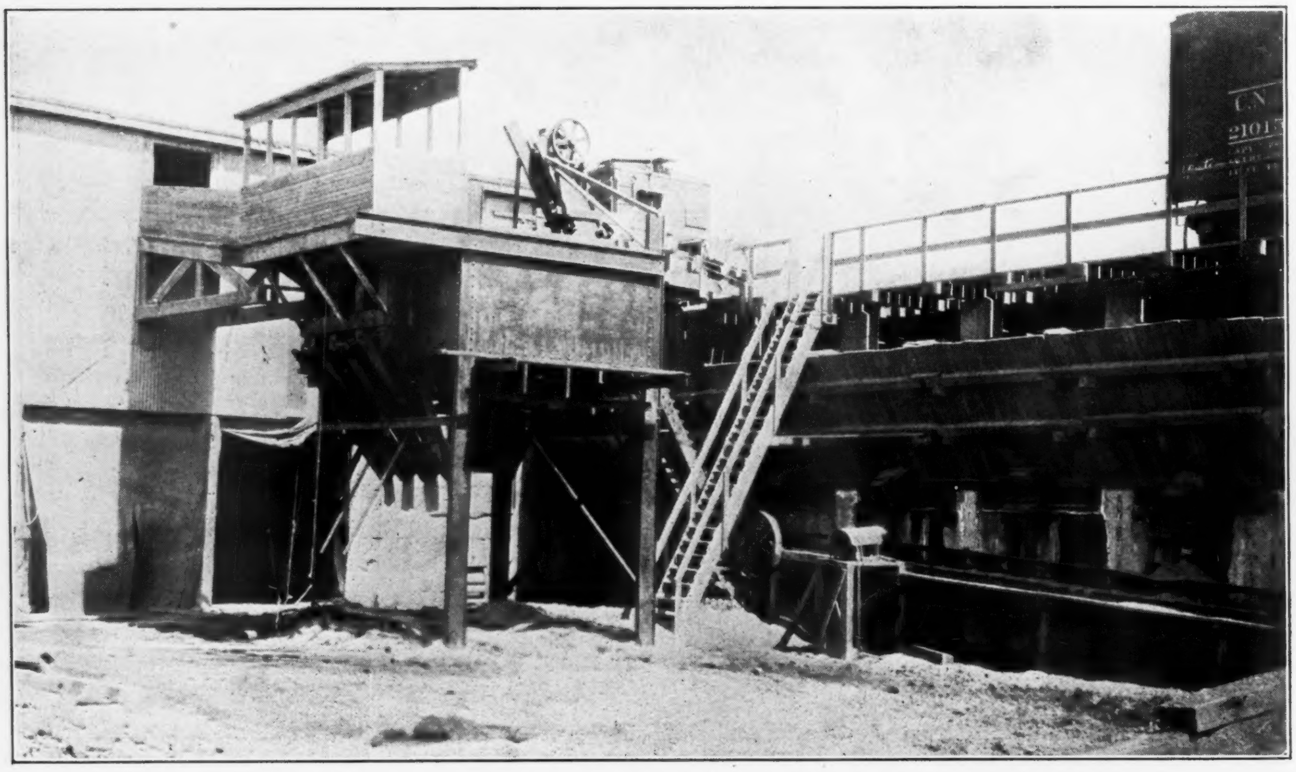
Well Drill at Top of Quarry

about 5 feet below the floor. Sixty per cent and 40 per cent Dupont gelatine are used for blasting. Block drilling is done with Denver number 37 jack hammers and compressed air is furnished by a 500 foot Ingersoll-Rand compressor.

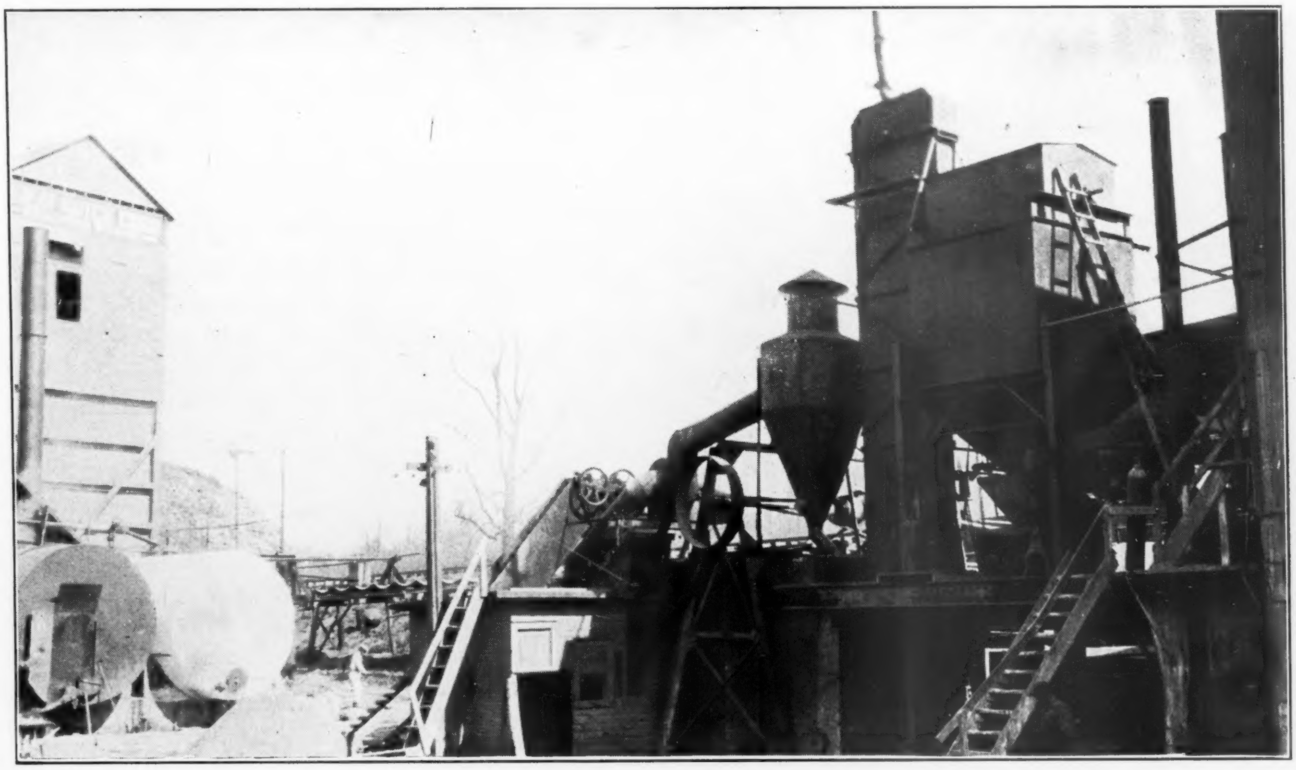
With the conditions at this quarry it has been found satisfactory to deliver the quarry stone to the primary crusher by truck and two 6 ton Autocars are used for this purpose. Two steam shovels are in the quarry for loading the trucks. One of these is a number 18-B Bucyrus, with a one yard dipper, and the other is an Erie with a ¾ yard dipper. The primary crusher is a 24x36 inch Allis-Chalmers (Worthington type) jaw crusher placed so that the Autocar trucks may dump directly into it. A Curtis air hoist is suspended above the crusher to handle any large stones.

Several interesting and unusual details have been introduced in this part of the plant. The large pulley on the crusher is covered with Rony pulley covering, manufactured by the Rony Manufacturing Company, to prevent slipping and abrasion of the belt. This is a cotton material cemented to the metal. The motor, which is a 75 hp. General Electric Company machine, is equipped with a pressed spruce pulley, made by the Compressed Spruce Pulley Manufacturing Company, which is also excellent from the viewpoint of its nonslipping quality. A Goodyear belt is used to drive the crusher but some of the other drives at the plant are Manhattan.

The primary crusher discharges into a 30 inch Robins conveyor which carries the stone to a 13 inch Superior McCully gyratory crusher. From here the stone is elevated by a 7½ inch Allis-Chalmers elevator, on 70 foot centers, to a 60 inch



Aggremeter With Conveyor From Under Sand Bins Which Are Below Railroad Tracks



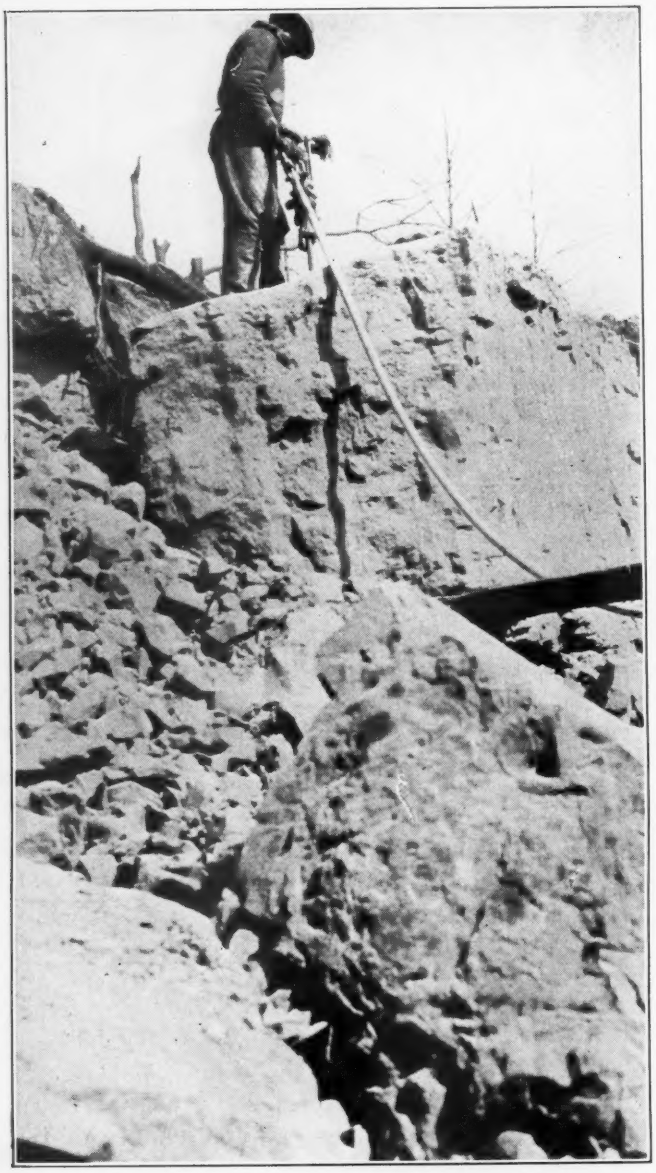
General View of the Asphalt Plant

by 26 inch Allis-Chalmers revolving screen. The material is here separated into six sizes and deposited in bins. Rejects from the screen drop into a 6 inch McCully reduction gyratory crusher. This discharges in turn into the elevator feeding the revolving screen.

The bins provided for loading the trucks are also arranged to feed into an 18 inch Robins belt conveyor for the purpose of carrying material to the asphalt plant, owned by the Franklin Contracting Company, a subsidiary of the Great Notch Corporation. Sand for this asphalt operation, which is an oil burning Cummer plant, is brought in from a distance by truck and dumped where it can be picked up by a bucket elevator. Stone for the conveyor is handled in like manner by a separate elevator. Some of the special equipment associated with the asphalt making plant is a Brown electrical pyrometer and a Toledo scale.

A few words regarding the maintenance of the

Crane Mounted on Truck Used for Making Stock Piles and for Loading Delivery Trucks From Stock Piles

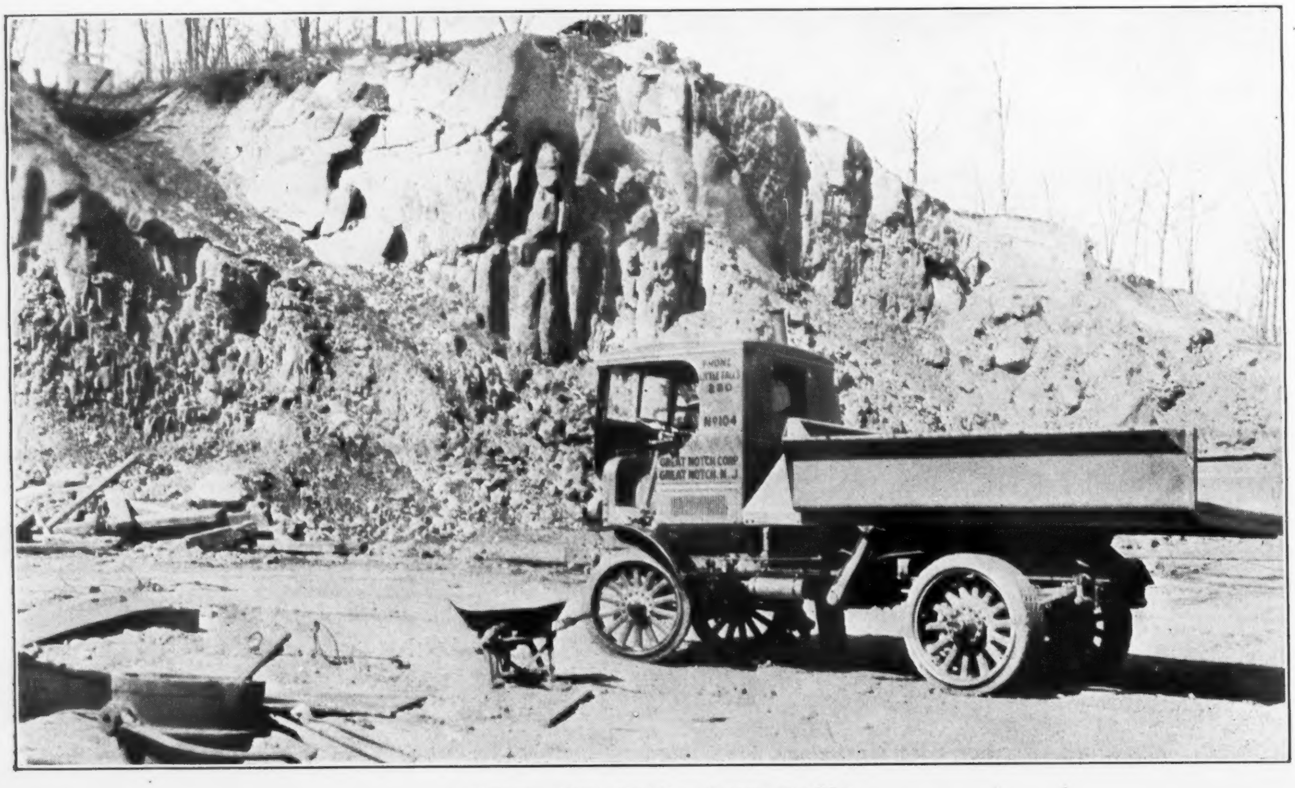


motors will no doubt be interesting. The absence of hot bearings on the motors is due to a very simple procedure and yet it is evidently effective. In the spring every bearing is washed out. During the operating season the bearings are oiled every day through the gauges, the caps over the bearings being never opened except for the annual washing out. It is an interesting fact that since the opening of these caps has been discontinued hot bearings have ceased to occur, obviously because this has made it impossible for grit to get into them. The motors are also blown out every autumn when the plant shuts down. The motors are all either General Electric or Crocker-Wheeler.

There is one other unusual device used at the plant which is worthy of notice because it also reduces maintenance, labor and out-of-service repairs to a minimum. This is a belt lacing device recently developed by Mr. Myers, the quarry foreman, and by its use one man can lace even the heaviest belts. The device operates so that the belt is held firmly with the ends closely abutting and the rivets when hammered in the curved belt fasteners do not flatten. Crescent fasteners are used for the belts.

The plant is located on the Greenwood Lake division of the Erie Railroad and a spur extends, along one side of it, on an elevated structure. Carloads of washed sand are brought in on the spur for use in an Erie aggremeter. A Robins belt conveyor runs along the bottom of the sand pile and carries the sand to an elevator which feeds the hopper over the aggremeter.

Three Universal cranes, mounted on Mack trucks, are used at the plant. At the office, which is in a small building by itself, there is installed a Myer truck scale.



Upper—Block Drilling Large Boulder
Lower—One of the Trucks Used to Carry Stone to Primary Crusher

BRIDGING THE GAP BETWEEN RESEARCH AND PROFITS IN LIME INDUSTRY

By W. E. Carson*

IF THERE is romance in the lime business—and it is rife with it—75 per cent of that romance can be traced to the chemist, for through his research and efforts this ancient industry is being re-established and brought forward as a sentient and living organism.

Twenty-five or thirty years ago the lime industry was asleep, and its awakening has been due to the persistent efforts of such men as those of which the American Chemical Society is composed. It has been a matter of great interest to see the awakening of manufacturers to the idea that the burning of lime is not alone dependent on the five senses, but that other elements, such as intelligence, enter into it, and that the long-used statement that "lime is lime" is not accurate.

The National Lime Association contributed to this awakening when a few forward-looking manufacturers got together to form an association to develop and bring forward the merits of lime. To our amazement, we found that before attempting our proposed program we had to educate the lime manufacturer to know something about his product and realize that his business had in it the elements of an industry and to inculcate within him a respect for the product he was manufacturing. At that time lime production was in the hands of either a farmer who had a deposit of limestone on his land or a building supply dealer who had purchased a quarry and put up a little plant with the purpose of getting a cheaper grade of lime than he could purchase. Therefore, the rescue of this industry from extinction might surely be termed a romance.

For about twenty years it was necessary to centralize our educational program on these embryo lime producers to get them to believe that their product should be developed as a manufacturing industry, and to put in better machinery, use better methods of manufacture, and acquire trade ethics.

That we succeeded, the lime industry itself today stands as testimony, but while we have made great strides we have not yet been able to drive home to a large number of lime manufacturers the last and most important step—the necessity of chemical control and of preparing their product to meet the chemical requirement of the process in which it is to be used.

A few excerpts from the minutes of some of these meetings may be of interest in showing the attitude that we had to meet in the early days. Going back to 1909, the following appears in the minutes:

Mr. Chairman—We are business men, and I cannot see why you should have taken up so much of our time this morning by having one of those engineers, or chemists, or whatever you might call them, to appear before us, as who wants to listen to such stuff as they get off. My father manufactured lime before me, and I'll bet he never heard such stuff as was pulled this morning. Let us quit this sort of talk, and attend to business at our meeting.

In 1910, the following appears:

Mr. Chairman—I wish you would see to it that no more of them highbrows appear before the Association. I don't know whether you pay these men for making speeches; if you do, you are just wasting the money of the Association—if you don't, you are wasting our time. What we want to do is to talk common sense and not about CO_2 and such stuff—who cares whether CO_2, CO_3 or CO_4 is in limestone or not—what we want to know is where we can buy our coal cheap, etc.

In 1911, Mr. Charles Warner offered a very able paper on "Combustion in Lime Kiln Practice." The following is taken from the discussion of his paper:

Mr. Chairman—I was astonished at Mr. Warner taking up the time of this Association with the paper that he offered, all full of scientific stuff; why, this is the sort of bull that is gotten off by those chemist chaps. We all appreciate the good work you are doing, in bringing us manufacturers together, but why waste our time on such discussions? Chemistry is all right for college professors, but let me tell you, the quickest way to ruin business is to start experimenting on it. I know a man outside of St. Louis who went broke because he did not take the advice of his old foreman, but listened to these chemists, who said they could burn lime with gas. Now, everybody knows that you can't burn lime except with wood.

In 1913 a member protested that we were beclouding the real issue in the lime industry by discussing such questions as the effect of sulphur in its reaction on lime. In the following year, a spirit of tolerance toward "them scientific chaps" began to be shown, for a request was made that a glossary be prepared to bring the general terms used in the lime industry into line with chemical terms, and at this meeting Dr. Lazell, an eminent lime chemist, was requested to prepare an article on hydrated lime, to be published at the expense of the association.

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*Presented before the Symposium on Lime at Richmond, April 13th.

Since that time there has been a steady growth in the belief that scientific knowledge is a necessity in the manufacture of lime, but it is only in a limited number of plants that as yet scientific knowledge is being applied to the product itself. Lime manufacturers have spent large sums of money to develop the best fire-resistant brick that it is possible to use in their process; they have investigated what is the best coal to use; they have studied the use of rotary kilns, gas kilns, and flame kilns; they have worked out the right size of stone to be used; they have employed mechanical experts to develop machinery to handle their product; and they have brought up their plants to a size and efficiency that makes the lime industry rank as one of the major industries.

All this has been done with the view of increasing output and decreasing cost of manufacture, resulting in the production and sale of lime at a very low price, often, unfortunately, without regard to quality. And this brings me to the main thought that I wish to emphasize—a thought which if it can be translated into accomplishment will be of more value to our industry and the more than one hundred and fifteen industries into which lime enters, or the six hundred different types of uses of lime, than any other one thing that can be done—namely, that each individual see to it that the company with which he is connected will not buy lime from any plant that does not employ a chemist, and that the purchase of this chemical commodity, lime, is not left entirely to the purchasing agent, whose sole thought is to chisel out a slightly lower price without considering the fact that limes differ as much as do human beings.

An analysis does not commence to tell the whole story in regard to lime. Many manufacturing plants, and large ones at that, buy their lime entirely on analysis, and do not consider the question of manufacture. This is one of the greatest mistakes that the purchasers of lime for chemical purposes are making. We know that the reactions of an overburned lime, a medium burned lime, and a lime that is burned at low temperature, although having the same analysis, are entirely different. In causticizing, where quick settling is desired, lime should be burned to show a low plasticity curve, while lime in the Steffen process in sugar-refining should have a high plasticity curve. These curves are obtained with the aid of the plasticimeter and the plasticimeter can only be handled accurately and properly interpreted by a technically trained man. This is a method by which the user of lime can know the temperature at which lime should be burned, and he should study the burning in order to determine the best heat for his process. In other words, not only should he know the chemical content of the lime, but also whether that lime should stay as long as possible before the fire or be moved from it at once, and this type of investigative work and control can only be effected by the plant chemist.

In every order for chemical lime the matter of analysis should enter, but a plasticity number should also be included. In commercial use chemical control is just as necessary as in the chemical industry. In one instance, failure to hydrate lime completely so that it was put on the market containing free lime caused great damage which would have been avoided had the lime plant been under chemical control. In admixtures with cement and cement mortars, quicklime is destructive, making an unsound concrete and mortar, and no lime plant, unless under chemical control, can be sure of the safety and soundness of its hydrate.

But, alas! chemists cost money, and laboratories are expensive, hence the lime manufacturer who competes on price only will not employ him, relying on the old adage that "lime is lime." Therefore, if we are to bridge the gap between research and profits in the lime business, the American Chemical Society must take a bold stand in condemning the purchase of lime for any purpose from any plant that is not willing to spend money through the employment of a chemist who will watch the production and shipment of lime and see to it that the particular type of lime needed for a specific process is prepared. The lime industry needs just such encouragement and policing to make it a one hundred per cent industry.

Cement Problems

Some pertinent questions concerning cement which require answers are: (1) How far does combination of lime and clay occur before sintering? (2) Why is the color of Portland cement clinker green black, while compounds of iron oxide are brown? (3) Why does the addition of a few per cent of fluorspar to portland cement clinker color the latter violet or violet brown? (4) Why, in spite of the thorough going parallelism between calcium barium and strontum, is there no known cement with a barium or strontium base? (5) How can the formation of tricalcium silicate be represented? (6) What is Alite? (7) What is the underlying cause of the great difference in hardening power of calcium aluminate and calcium ferrite? (8) Why is fused cement sometimes gray and sometimes brown, but never the color of portland cement? (9) Why does the addition of gypsum and calcium chloride increase the strength? (10) Why has rapid setting cement, in spite of its stronger reactivity, almost always a lower strength value? (11) What is the reason for the fact that large masses of concrete always have greater strength on the surface than in the interior? (12) Why is it that bituminous additions to cement mortar and concrete make it watertight? (Dr. Hans Kuehl, Zement, March 17, 1927, 200-201.)

ROTARY KILNS VERSUS SHAFT KILNS FOR LIME BURNING

By Richard K. Meade*

IN THE following discussion of the relative merits of shaft and rotary kilns, it should be borne in mind that the author intends to submit no brief for either type. He has had many years experience in the construction and use of both styles of lime kilns. During the past year he has built a number of shaft kilns and is now building a rotary kiln plant in New Jersey. Nor does he in the following discussion intend to cover fully the subject of lime burning in these two types of kiln, but rather to indicate the most striking points of comparison between the two.

In comparing two types of kiln, the discussion is largely along the lines of the comparative (1) suitability of the kiln to the raw materials, (2) the quality of product produced, (3) the economics of labor, fuel and repairs and (4) the first cost of installation.

Suitability to the Raw Materials

All shaft kilns require that the stone must be in pieces ranging in size as a general rule from 4 to 10 inches. With the rotary kiln the stone should not be greater than 2.5 inches and the kiln will successfully burn dust and even such an impalpable material as alkali-waste. Generally speaking, the rotary kiln will burn the stone more uniformly if it is fairly regular in size. It is the practice at some works, therefore, to sort the stone into sizes by means of a screen, store the stone in bins, and burn each size separately.

So far as I have been able to judge there are no limestones suitable for burning in a shaft kiln which are not also suitable to burning in a rotary kiln provided they are properly prepared for the latter by means of crushing. On the other hand, there are numerous limestones which can not be burned in a shaft kiln but which can be burned in a rotary kiln. With a shaft kiln, if the stone is too small, the smaller material works its way into the crevices between the larger stones and chokes the draft, not only decreasing very materially the output of the kiln but also causing irregular burning of the lime.

For the above reason, the shaft kiln can not be economically employed for burning quarry spalls or stone smaller than an average of 6 inches diameter, for burning stones which when heated decrepitate and fall to small pieces, or for burning very soft chalky limestone which has not the necessary crushing strength to hold its shape in the kiln.

During the preparation of stone for the shaft kiln (or for furnace flux) large quantities of small stone (spalls) are often produced. The disposal of this material, particularly during certain seasons of the year and at certain quarries, is a problem. Quite a number of manufacturers have, therefore, installed rotary kilns in connection with their shaft kilns for the express purpose of burning these spalls.

There are certain limestones which can not be burned satisfactorily in a shaft kiln owing to the fact that when the heat strikes them they fall into small pieces. In some cases, this action is very marked, the stone being almost reduced to dust. Good examples of this are the highly crystalline limestones found at North Adams and other points in northwestern Massachusetts and in the neighborhood of Franklin Furnace, New Jersey, some of the purest ledges of which have never been successfully burned in a shaft kiln for this very reason. Another limestone which is difficult to burn in a shaft kiln, but which can be burned in a rotary kiln, is the soft chalky limestone found in central Florida.

Still other examples are the coral sands which form the shores of certain islands in the Pacific Ocean and shells and shell marl. All of these materials are now successfully burned in rotary kilns.

Quality of Product

The quality of the product of any lime kiln will depend primarily on that of the stone burned. Pure lime can only be made from pure limestone, etc. So far as burning goes the quality of the lime is most affected by the completeness with which the stone is dissociated into calcium oxide and carbon dioxide. Or in common parlance, how much "core" is left in the lime. With the shaft kiln, the lime being in large pieces, the latter can be picked over by hand and any unburned lumps discarded. In the case of some shaft kilns, notably the large gas fired kilns, the amount of core so obtained often amounts to a considerable percentage. It is certain that the "run-of-kiln" lime from the rotary kiln is fully as well burned as the "run-of-kiln" from the shaft kiln, but owing to the condition of the rotary kiln product no sorting is possible, while in the shaft kiln the best material can be selected and sold to the builders while the "culls" are sold for agricultural and other less exacting uses. From the nature of things this selected lime should be better than the run-of-kiln material, particularly where the kiln is not skillfully handled.

In the past, there has been considerable objec-

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*Presented before the Symposium on Lime at Richmond, Va., April 14, 1927.

tion to the product of the rotary kiln, especially in the building trade. This prejudice was to a considerable extent due to ignorance on the part of the builder. Fine lime was usually the result of air slaking, and as air slaked lime is partly reverted to the carbonate, it was natural that the builder should demand lime in lumps. As the product of the rotary kiln ranged in size from 2 inches to dust and is often much finer than this, on being supplied with the finer product of the rotary kiln the builder supposed he was obtaining air slaked lime; or at any rate, fine and hence inferior lime. The product of the rotary kiln was always accepted as satisfactory for chemical and metallurgical purposes—the finer condition being an advantage. Here the user often burned his own lime and sometimes, as in the case of carbide, conveyed it hot from the kiln to the electric furnace. There have for years been numerous rotary kilns burning lime in sugar, paper-pulp, ammonia, carbide and metallurgical works, and until recently much of the lime burned by lime manufacturers themselves in rotary kilns was sold to chemical and metallurgical industries.

Gradually the prejudice of the building trade to the use of rotary kiln lime has been overcome. Now much of the product of rotary kilns finds its way into the building trade. "Granular-lime," "pebble-lime" and other popular brands are products of the rotary kiln. Experience in the use of the rotary kiln has taught certain manufacturers how to burn lime in this which will meet the requirements of the building trade. Screening the lime into products of several sizes, designed to meet the special requirements of definite users, has also helped to make the rotary kiln product acceptable.

The introduction of "pulverized lime" in the building trade has made possible the sale of rotary kiln lime for mortar purposes on a scale not heretofore deemed possible. It has been found that if lime is ground to such fineness that all of it will pass the standard 30-mesh screen, the plaster made from this will not pit even when the mortar is allowed to soak for only a few hours. The popularity of fine lime is, therefore, due to the shorter time between slaking and using—an important thing in cities where space for mortar boxes is limited and quick handling is desirable.

Since the smaller the lime pieces the easier they can be pulverized the rotary kiln product offers a better starting point for pulverized lime than the larger product of the shaft kiln. It has also been found of no disadvantage and possibly of advantage to have a small percentage of unburned material in pulverized lime, hence there is no objection to a small amount of core such as is sometimes left in rotary kiln lime if the latter is too lightly burned.

Lime can be burned much more completely in a rotary kiln than in a shaft kiln. Where necessity demands a fully burned material, with only a few tenths per cent of carbon dioxide left in this, it is almost an impossibility to burn to this extent in a shaft kiln but relatively easy to burn down to 0.25 per cent CO_2 in run of kiln product in the rotary kiln. This is, of course, of interest only to metallurgical and electro-furnace users. Formerly considered only as useful in burning lime for agricultural, metallurgical and agricultural use, much of the product of the rotary kiln is now meeting all the requirements of the most exacting users and even in some instances being given preference by these over the shaft kiln product.

Economic Production

The quarrying of stone for the rotary kiln is more economical than this operation for a shaft kiln. This is due to the requirement that the stone for the shaft kiln shall all be broken to pieces not larger than from 8 to 10 inches or smaller than 3 or 4 inches. The necessity of having the stone of this size increases very materially, not only the labor, but also the waste in the quarry. Where the small stone, or spalls, can be sent to a cement plant or other use can be found for them, the item of waste is not great, but where they must be thrown away, the loss from this source is considerable.

Where a rotary kiln is employed, the saving of labor in the quarry is very noticeable. The sledging of the stone to proper size for the shaft kiln and the necessity for hand sorting and forking add much to the cost of quarrying. The crushing of the stone to 2 inch size does not represent anything like the operation that hand sledging does. Furthermore if the tonnage handled is large enough to justify its use economically and the stone does not have to be sorted in order to throw out impure material, a steam shovel may be employed for loading. Of course, where lime operations are large enough to justify the outlay, large crushers followed by screens may be used to crush and size stone for shaft kilns. In order to justify this, however, quarry and crushing operations must be large, certainly over 500 tons daily, whereas with the rotary kiln the crushing unit can be made to match the output desired.

The power required to crush the limestone may be safely figured at about 1¼ H.P. hours per ton of limestone crushed which is equivalent to 2½ H.P. hours per ton of lime produced (1.87 kw.hr.). Whether power is purchased or generated, this expense would prove small in comparison with hand sledging. When limestone is purchased, it can generally be obtained crushed and screened to definite size cheaper than sledged to shaft kiln feed and, where it is received at the lime plant by rail, crushed stone is the more easily handled of the two.

Actual comparative figures of costs are hard to obtain because few quarries are operated under similar conditions and where shaft and rotary kilns are employed side by side one is usually burning hand-picked stone and the other spalls, etc. Figures are obtainable, however, at numerous quarries where the same rock is sent to both crushers and shaft kilns. Here it is generally customary to pay more for stone sent to the lime kilns than for that sent to the crusher—at some plants, as much as 50 per cent more. For example, at one quarry furnishing furnace-flux and also burning lime, where occasional lenses of bad stone must be discarded for both purposes, the loaders are paid 37½ cts. per ton for kiln stone and 25 cts. per ton for rock sent to the crusher, etc. It must be remembered, however, that the rotary kiln will not make good lime out of spalls where clay and over-burden are mixed with these. Where the stone must be forked to free it from these impurities, the cost of loading shaft kiln stone and rotary kiln stone approaches more nearly the same figure because the waste rock is about the same in both instances.

Labor of Operation

The labor required to operate the grate fired shaft kiln is very considerable. In addition to the firing, considerable labor is required in drawing, particularly where the lime "sticks." On an average, one man is required to fire and tend each shaft kiln. The ordinary shaft kiln of this type reduces from 8 to 25 tons of lime per 24 hours. A 6 ft. diam. by 125 ft. long rotary kiln will produce 50 tons of lime per day. Rotary kilns are now in operation which burn 175 tons of lime per day and it is probable that one of the large rotaries such as are used in the new wet-process cement plants (11x200 ft.) would burn 350 to 400 tons. One attendant can easily look after one of the latter kilns or two or three of the former if the plant is properly arranged. The same man usually operates both the gas producer and the kiln. Naturally if oil is used less labor is required than with coal. The labor required to crush the stone, handle the latter and see that it is being fed into the kiln properly is no more than that necessary to charge the ordinary shaft kiln.

At a well equipped plant comprising six shaft kilns producing about 100 tons of lime per day the labor required is as follows:

2 men charging the kiln, 1 shift (10 hrs.).
6 men burning, 2 shifts (12 hrs.).
1 man handling coal and ashes, 1 shift (10 hrs.).
2 men drawing, 2 shifts (10 hrs.).
—
19 men—Total for 100 tons.

This, of course, does not include the labor of packing and loading the lime. At this plant the labor of burning, including charging and drawing the kiln, amounts to 2.2 man-hours per ton of lime produced. This plant is equipped with a pan conveyor for handling the lime and an elevator and bin for handling coal.

At a rotary kiln plant with a capacity of nearly 150 tons per day in the same section of the country, the labor required on the day shift is as follows:

2 men at crusher and placing stone in the bin, 1 shift (8 hrs.).
1 man burning, 2 shifts (12 hrs.).
1 man oiling and tending stone-bin, 2 shifts (12 hrs.).
1 man handling coal and ashes, 1 shift (10 hrs.).
—
7 men—Total.

At this plant the labor of burning, including crushing, amounted to 0.6 man-hours per ton.

When the rotary kiln plant is smaller, the difference in labor cost becomes less noticeable. It follows, therefore, that the rotary kiln is chiefly adapted to fairly large tonnages and that for small outputs, 50 tons or less, the shaft kiln plant, if well designed, employs but little more labor than the rotary kiln plant.

Fuel Economy

Pulverized coal, producer gas and oil are all now successfully used for heating the rotary kiln. Pulverized coal is probably the most economical fuel and is also easy to handle. Oil is the most convenient fuel but it is more expensive than coal in most localities. It is the cheapest installation to make. Producer gas is the most expensive system to install and it is also the most troublesome to apply. The producer itself is difficult to operate so as to give a uniform supply of gas both as regards quantity and quality. Producer gas is not as economical as pulverized coal and more fuel is required when the coal is gassified and burned than when it is used in the pulverized condition. Unfortunately, where pulverized coal is employed, some of the ash of the latter enters the lime. This, of course, reduces the purity of the lime. Actual tests show that employing a coal containing 11 per cent ash, the amount of the latter entering the lime is sufficient to increase the impurities in a certain lime from 2.9 per cent to 3.6 per cent and to decrease the calcium oxide from 95.0 to 94.3 per cent.

It is interesting to note that in spite of the fact that the use of pulverized coal to burn lime is much more economical than that of oil and producer gas, the majority of lime manufacturers who are employing rotary kilns will not now consider using powdered coal because the ash of this enters the lime and having introduced their product into the most exacting classes of trade they will not consider any economies which might detract from its high quality.

Of the fuels mentioned above, oil and producer gas are both extensively employed for heating shaft kilns. Pulverized coal has never been successfully employed with this type of kiln—possibly because this fuel has never been tried by those who understood it or were willing to make the necessary changes in their shaft kilns to meet its requirements. The question of the contamination of the lime by the fuel ash applies here also. By far the greater majority of shaft kilns are heated by means of coal burned on either hand-stoked or mechanical grates. Theoretically, gas firing of shaft kilns seems to offer many advantages over hand firing of coal on grates. In practice, the gas fired kilns, while unquestionably showing better economy of fuel, have developed other troubles which make it doubtful in the minds of most lime manufacturers and engineers if the producer fired kiln, when considered from all angles, is any improvement over the better types of hand fired kiln. For the purpose of this paper, therefore, I am comparing rotary kilns with shaft kilns fired by hand.

The fuel requirements of shaft kilns vary largely. Undoubtedly expert handling and good firemen have much to do with the results obtained. The grate surface allowed, draft and other matters influencing the combustion of coal undoubtedly affect economy also to a considerable degree. The relative height above the arches and the internal diameter of the kiln, other things being equal, affect the fuel economy of the shaft kiln more than anything else. (Just as they do with the rotary kiln). Tall narrow kilns operated with induced draft require less fuel per ton of lime than do the lower kilns of relatively large diameter operated by natural draft. Similarly of two rotary kilns of the same internal diameter but of different lengths, the longer of the two will take less fuel. The fuel requirements of both rotary and shaft kilns, therefore, vary largely among themselves.

A shaft kiln heated by a good grade of run of mine gas or slack coal will burn from 2.5 to 4 lbs. of lime per pound of coal. Or a fuel: lime ratio of from 1:2.5 to 1:4. A rotary kiln heated by producer gas will have a fuel ratio of from 1:2.5 to 1:3.5. If the kiln is heated by pulverized coal the fuel: lime ratio will be 20 to 30 per cent higher.

In the matter of fuel economy, I am inclined to give the well designed shaft kiln the preference over the rotary kiln. I believe that for burning the better grades of building lime and employing producer gas, the rotary kiln will require on an average from 10 to 20 per cent more fuel than the shaft kiln. For burning chemical and metallurgical lime the requirements are more nearly equal. Where pulverized coal or oil can be used the fuel: lime ratio is about the same for the two kilns.

In comparing the fuel requirements of the two outfits, however, we must remember the possibility of recovering much of the heat lost in the rotary kiln—something which may be dismissed as impractical with present equipment in the case of the shaft kiln. It is now common practice in the cement industry to operate the entire plant by the steam generated from the gases of the kiln by employing waste heat boilers.

The waste gases leave the kiln at about 1200-1400 degrees Fahr. and hence contain a large part of the heat liberated by the burning of the fuel. This heat can be successfully utilized in boilers as has been done to a small extent in the lime industry. In the cement industry by cutting down air leakage and the use of economizers following the boilers an efficiency of 70 per cent has been obtained. The weight of gases usually amounts to between 8,500 and 10,000 lbs. per ton of lime produced. The heat in these gases will, therefore, be approximately 2,800,000 B.t.u. This is about one third of the total energy of the coal burned, the other two thirds being utilized in the decomposition of the limestone or lost in radiation from kiln and cooler shells. Of the heat in the flue gases, as much as 75 per cent has been successfully utilized by waste heat boilers in the cement industry. This would amount to 2,100,000 B.t.u. per ton of lime produced. This is equivalent to 1926 lbs. of steam at a pressure of 200 lbs. per sq. in. and 100 degrees superheat, or 62.7 boiler horsepower. In a modern turbo-generator set, the requirements are about 17½ lbs. of steam per kw.hr. at the switchboard. If so used, therefore, the above quantity of steam would produce 110 kw.hr. A kiln burning 4 tons of lime per hour, therefore, would be good for about 440 kw.hr. Most lime plants are operated in connection with crushing plants, mills for grinding lime, pulverizing limestone or hydrating lime, so that this power can generally be utilized. The kiln, crusher and accessories will not require more than one-fifth of this, leaving about 350 h.p. for outside uses.

In the cement industry the results are even better than this. At many plants from 3 to 4 lbs. of steam are generated per pound of coal burned in the kiln and the conditions are not so different in the two industries. It is only fair to say, however, that the installation of a modern water tube boiler, economizer, superheater, turbo-generator, condenser, etc., to produce this amount of power would represent a considerable investment, possibly a greater investment than the kiln itself, and against this power must hence be charged a considerable interest and depreciation item. Where lime manufacturers generate their own power, however, the matter of rotary kilns and waste heat boilers should receive careful consideration.

Repairs

Repairs to both the shaft and rotary kilns are confined largely to the renewal of the fire brick in the hottest part of the kiln. In the shaft kiln the arches and the fire brick adjacent to these are subject to frequent renewals, while in the rotary kiln about 15 or 20 feet of the lining has to be renewed. In the case of either the shaft or rotary kiln it is usually necessary to make repairs after from 6 to 9 months service. The repairs in the case of the rotary kiln are much easier made than in the case of the shaft kiln. Since the shaft kilns seldom have a larger capacity than from 15 to 25 tons of lime per day each and since the rotary kilns are usually employed only for large capacities, 50 tons or more, the greater number of furnaces to be repaired in the case of the shaft kilns puts these at a comparative disadvantage with the rotary kiln. With the shaft kiln too, the employing and recharging of the kiln are operations of considerable magnitude. Cooling, drawing down, charging, heating up, etc., all take time and much labor. In the case of the rotary kiln it is only necessary to allow the kiln to cool, clear out a few tons of crushed material, take out the damaged lining and replace. Usually the operation of the kiln is only interrupted for three or four days and within two or three hours after applying the heat the kiln is turning out practically its full output of good lime. Occasionally repairs have to be made to the mechanical parts of the kiln. I have known a roller to break and after several years use some of the gears in the drive have to be renewed. If a gas producer is employed, the repairs on this are much heavier than on the kiln itself.

Actual comparative figures on the cost of repairs mean little, because the care with which both the shaft and rotary kilns are operated have such a large bearing on this. A rotary kiln lining should last at least 6 months. At the end of this time, about 20 feet of this lining may need renewal. The cost of this work in the case of a 6 foot x 125 foot rotary will amount to about $350 for brick and labor. During 6 months time this kiln will have burned if operated at capacity about 9000 tons of lime, so that the repairs to the lining will amount to about 4 cts. per ton of lime produced. This represents, however, very good operation and lining repairs usually cost from 6 to 10 cts. per ton of lime.

My own experience has been that repairs to the shaft kiln are seldom so low as this and are generally at least twice this much. If, however, the repairs to the gas producer, where this is used to heat the rotary kiln, are also considered and added to the cost of kiln maintenance, as they should be, the repairs on the two types of kiln, grate-fired shaft kiln and producer-fired rotary kiln, are more nearly equal.

Cost of Installation

The cost of a rotary kiln lime plant including the crusher, kiln and cooler, motors and building but exclusive of arrangements for packing and loading will amount to from $1250 to $2000 per ton of lime capacity, depending on fuel employed, etc. The cost of a modern grate-fired shaft kiln plant inclusive of incline and hoist but exclusive of packing, building, etc., will range from $1000 to $1500 per ton of lime capacity for first class equipment.

A waste heat boiler plant if desired will probably add from 50 to 75 per cent to the cost of a rotary kiln lime plant, depending on the equipment selected. It will be seen from the above that the first cost of a rotary kiln plant is from 25 to 35 per cent greater than that of a grate-fired shaft kiln of similar capacity.

Miscellaneous

Where induced or forced draft is not included in the shaft kiln operation, the power required to operate the latter is confined to that necessary to hoist stone to the top of the kiln. This is, of course, practically negligible—say 0.25 kw.hr. per ton of lime burned.

The power required to operate the kiln is about as follows per ton of lime produced.

To revolve kiln, feeder, etc.	3.2 kw. hr.
To revolve cooler	2.0 kw. hr.
To elevate stone, operate producer, etc.	1.0 kw. hr.
Total	6.2 kw. hr.

Where pulverized coal is employed to heat the kiln about 6 kw. hr. are needed to prepare the latter.

The dust loss from the rotary kiln is appreciable. It probably amounts to from 1 to 3 per cent of the limestone fed into the kiln, depending much on the character of the stone, etc. If this is likely to be a nuisance in the community, as where the lime plant is located near a town, it may be necessary to collect this dust by means of a Cottrell precipitator, washer or some other device such as is used in the cement industry and at one or two lime plants.

Summary

1. The rotary kiln is suitable for burning all classes of limestone including quarry spalls, limestone which decrepitates on heating, soft chalky limestone, coral-sands, shells, marl, and other forms of calcium carbonate which can not be burned in shaft kilns.
2. There is little choice in the quality of the run-of-kiln lime from shaft and rotary kilns, but the product from the former can be more easily hand picked, giving an opportunity to produce selected material of higher quality than the average.
3. With care lime can be burned in the rotary kiln which will meet the requirements of the building trade as well as chemical and metallurgical users.
4. It is possible to burn lime more thoroughly in a rotary kiln than in a shaft kiln.
5. The rotary kiln is better suited to the production of pebble lime and pulverized lime than is the shaft kiln.
6. The quarrying of stone for a rotary kiln can be more economically done than for a shaft kiln.
7. The crushing of stone for a rotary kiln can be done more cheaply than the sledging and hand sizing of the rock for a shaft kiln.
8. The labor required to operate a rotary kiln plant is much less than that required to operate shaft kilns. The larger the operation the more pronounced the difference.
9. The shaft kiln is more economical of fuel

than the rotary kiln, particularly where producer gas is used to heat the latter.

10. Considerable of the heat lost in the flue gases of the rotary kiln can be recovered and converted into power by the use of waste heat boilers.

11. Repairs to the rotary kiln are less than those of a shaft kiln and the loss of time due to the repairs is also much less.

12. The cost of a rotary kiln plant is about 25 to 30 per cent more than that of a shaft kiln plant of similar capacity.

13. The power required to operate a rotary kiln is about 5 to 8 kw. hr. per ton of lime produced. If the kiln is heated by pulverized fuel the power required is from 13 to 16 kw. hr. per ton of lime.

14. The dust losses from a rotary kiln lime plant amount to from 1 to 3 per cent of the stone burned.

Conclusions

The rotary kiln is best suited to burning lime, (1) where run-of-kiln lime will meet the requirements of the market; (2) where quarry spalls, highly crystalline and very soft limestones, shells, marl, etc., are to be burned; (3) to large outputs; (4) to continuous operation; (5) where labor is high; (6) where fuel is cheap, where oil is obtainable as a fuel, or where pulverized coal can be used; and (7) where waste heat boilers can be installed and the surplus power so obtained employed to advantage in other operations. The shaft kiln is suited, (1) where it is advisable to select the lime in order to secure a product which will meet the most desirable trade; (2) where the limestone is hard and compact; (3) to small operations; (4) where low first cost is desirable; (5) where the demand for lime is likely to be variable; (6) where labor is cheap and fuel high; (7) where power is not obtainable; and (8) where dust is likely to cause a nuisance.

Chemical Industries Exposition To Be Huge Affair

The eleventh exposition of chemical industries will be held September 26 to October 1, 1927, at the Grand Central Palace, New York City. Many new materials will be exhibited for the first time and which will tend to broaden the scope of the student's course which is arousing interest throughout the trade as well as in all industry served by the chemical industries. The management is preparing a brief on the student's course which will be widely distributed among chemists, colleges and industries.

The exposition serves and helps to supply the market for more than forty different industries. It is through such a medium that the various methods, processes, machinery and instruments of precision used in manufacturing and handling chemicals are shown and demonstrated.

The past year of 1926 brought out the following contributions to industry by American chemists: It has been shown that Silicon can replace tin as a hardening agent for copper and is already in considerable use for this purpose; a new and rapidly expanding use for chlorine has been developed in the production of Ethylene Glycol, which may replace glycerine in many applications; about forty new Azo-colors have been developed in American research laboratories during the past year and placed on the market by our dyestuff manufacturers. The examples mentioned are only a few of the outstanding chemical and scientific developments in the field.

At the numerous sections of the exposition, many new developments will be exhibited and these in connection with the various papers which will be read would indicate that this will be the best chemical industries exposition that has been held.

Portland Cement Association Plan Safety Meeting

The Annual District Safety meeting of the Portland Cement Association will be held at the Elks' Club, Number 31 South Eighth Street, Allentown, Pennsylvania, at 2 p. m., daylight saving time, May nineteenth.

The following is a tentative arrangement of the day's program:

1. Mr. A. J. R. Curtis, Portland Cement Association
   "The June Campaign"
   Discussion
2. Mr. Chas. Waters, Secretary,
   Pennsylvania State Department of Labor and Industry
   "Safety Education"
   Discussion
3. Dr. E. H. McIlvane, Edw. G. Budd Manufacturing Company, Philadelphia, Penn.
   Discussion
4. Mr. D. A. Farace, Alpha Portland Cement Company
   "Mi Avete Capito?"
   Discussion
5. Mr. David Adam, Safety Director,
   Lawrence Portland Cement Company
   Discussion
6. Mr. W. H. Weitknecht, Superintendent,
   Lehigh Portland Cement Co., Mitchell, Indiana
   Discussion
7. SPECIAL FEATURE
   Three-minute addresses from each company's representative
   Discussion
8. Dinner served at Elks' Club at 6:30 P. M.
   (Daylight Saving Time)
9. Music—The Yost Brothers' Orchestra
10. Speaker—Col. E. M. Young, President,
    Lehigh Portland Cement Co., Allentown, Pa.
11. Close at 9 P. M.

THOMASVILLE STONE AND LIME COMPANY OPERATES LABOR SAVING PLANT

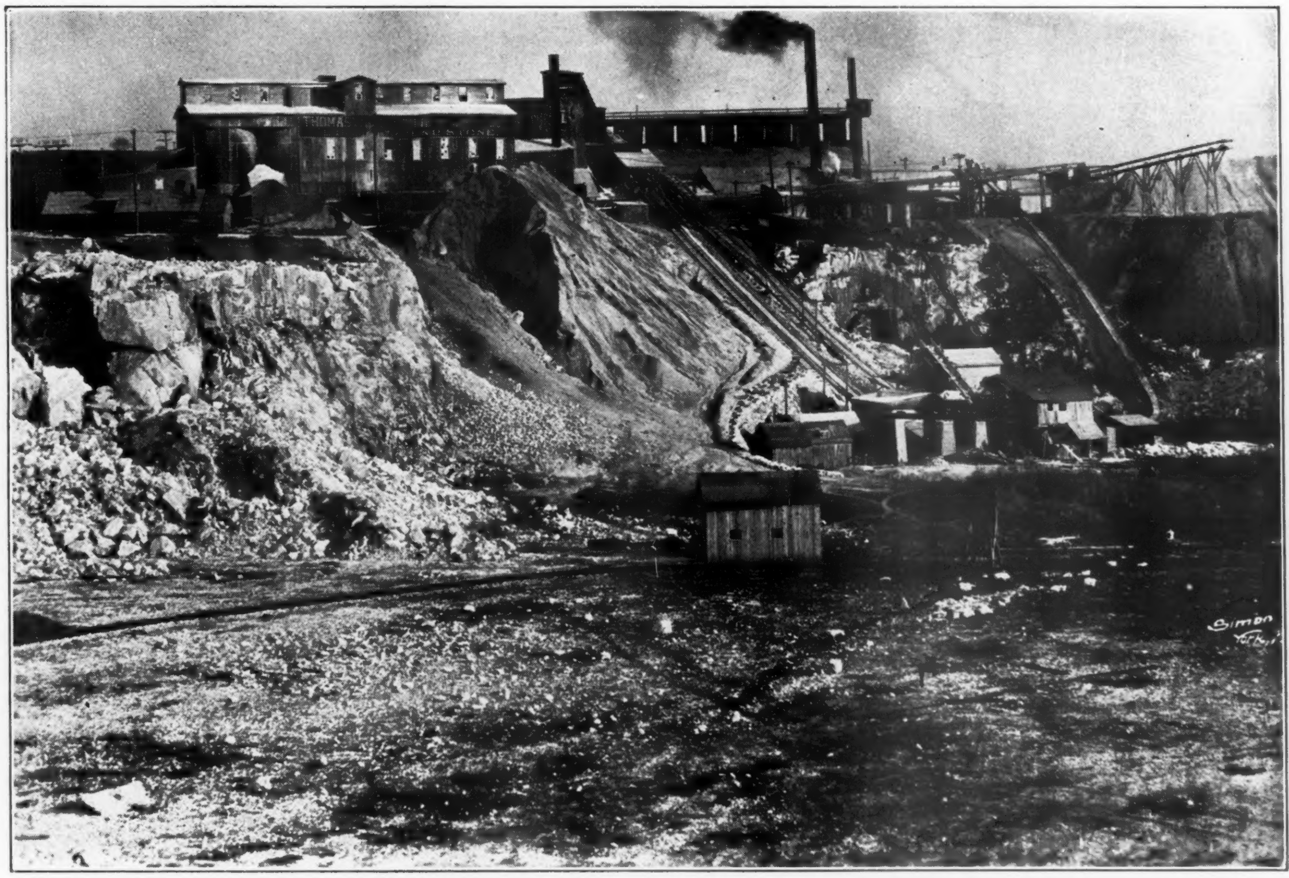
EIGHT miles south of York and a half mile west of Thomasville in York County, Pennsylvania, will be found the plant of the Thomasville Stone and Lime Company. The three most important features of this plant are the deposit, the small labor force and the excellent business which has been built up during the past twenty-one years of business.

The deposit covers 300 acres which is all owned outright by the company. The quarry is the largest in York County and contains large quantities of the best stone in the district. The major portion of the quarry consists of excellent oolitic limestone which is noted for its qualities throughout the chemical industries. The quarry face is about 1,200 feet long and the quarry has been opened to form a circular pit and is extended downward in benches 22 feet deep. Test holes have shown a uniform quality of stone extending to a depth of 185 feet. The beds are nearly horizontal and the slight elevations of ground are due to folding and the variations in thickness of the overburden. The overburden averages about four feet. The deposit contains prominent pointing and bedding planes and numerous pockets which have been filled with coarsely crystallized calcite.

The stone is rather fine grained and very soft. Its color varies from white to pale blue, dark blue or pink in the different beds without any appreciable change in the chemical composition. There is a dolomite layer with a pinkish tint on the west side of the quarry near the top but the remainder of the quarry with a working face of 60 feet contains excellent high calcium low silica stone. A good portion of the deposit consists of limestone conglomerate.

About 30 men comprise the entire labor force and the average daily production is 1,800 tons. One reason for this small force is due to a one-man quarry control system whereby the loaded dump cars move to the crusher and return under a signal system directed by one man. The overburden is removed with an Erie type B steam shovel with a ¾-yard bucket and loaded into trucks which haul it away to the waste dump.

Drilling is done with two Loomis gasoline well drills. Trojan powder and Cordeau-Bickford fuse are used. A shot releasing more than 50,000 tons of stone made during the last week of April is shown. Ingersoll-Rand jackhammer drills are used in the secondary drilling and shooting. The broken stone is loaded by three Erie type B steam shovels



Note the incline to the extreme right and the double incline in the center. The center incline leads to the kiln, the incline on the right leads direct to railroad cars.

Part of the 50,000 Tons of Stone Released by Recent Shot.

Quarry View Showing the Three Shovels and Individual Tracks from Shovel Converging at Main Track.

Blast which Released 50,000 Tons of Stone.

into four-yard Koppel cars which are hauled by a Porter steam locomotive and a Plymouth gasolene locomotive to the plant. The illustrations show the efficient track layout. Twenty men are all that are involved in stripping, blasting, loading and transporting to the plant. There are three tracks, each leading from a shovel, which converge into a main line track leading to the crushing plant. There are three switches in the system and these are controlled from one point by one man who also fastens the cable to the cars at the foot of the incline leading direct to the plant. Each switch is several hundred feet apart and operated by a central control lever. The system is not only a labor saver but also a time saver, as it is operated so as to keep the cars moving all the time. The locomotive with a string of loaded cars comes into the foot of the incline and runs the loaded cars into a storage track and is cut loose and returns to its shovel with a string of empties.

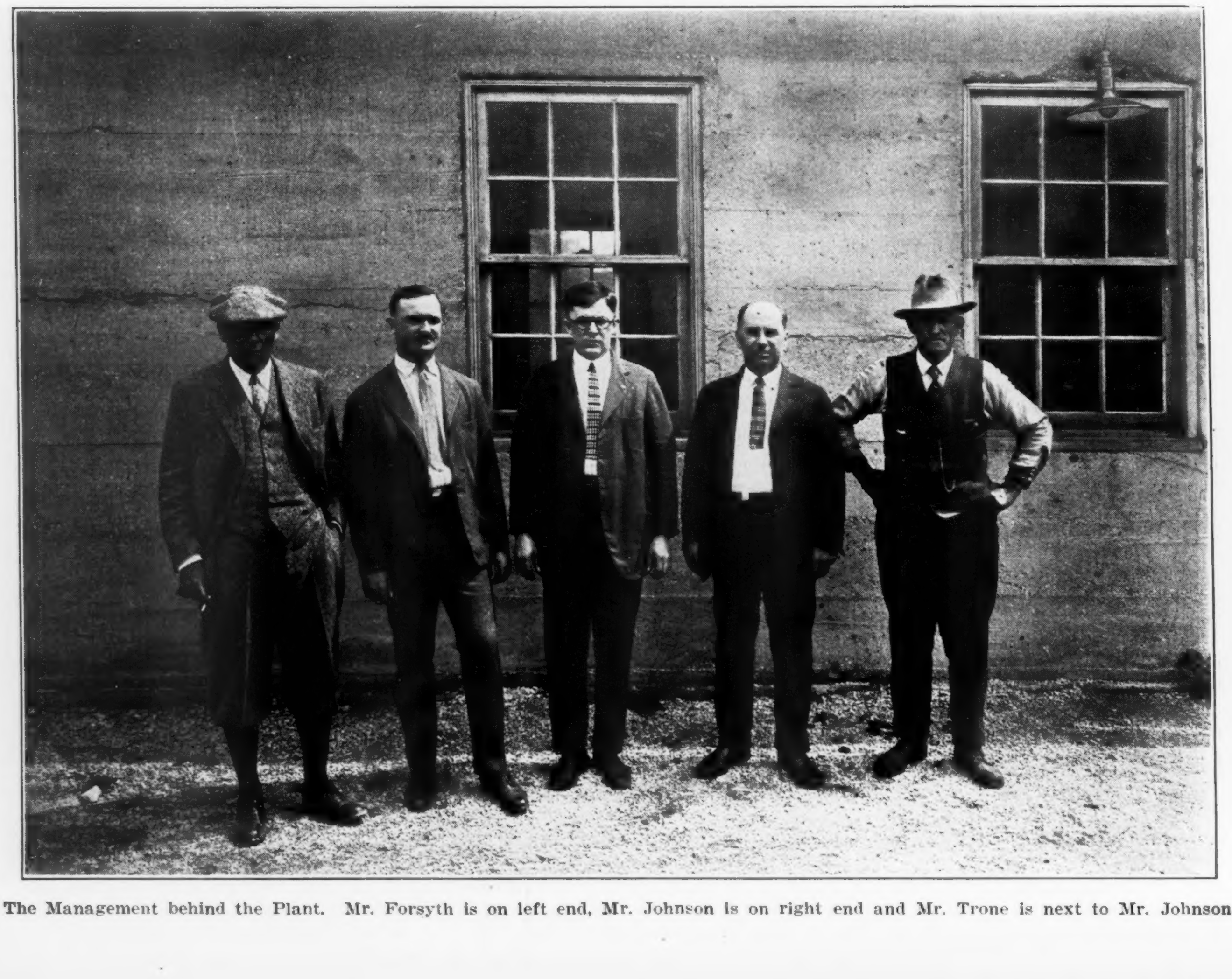
The loaded cars are hauled up the incline by cable and the last car up is discharged first into the primary crusher and the string then proceeds back down the incline, discharging each car in

The Fourteen 11x60 Foot Kilns.

Another Quarry View Showing Some Excellent Stone.

order. The plant proper was designed and built by the Link-Belt Company.

The primary crusher is a Worthington jaw crusher 40 by 42 inches and is set on concrete foundations. The receiving hopper is twelve feet above the quarry floor. The crusher is set to discharge at 8 inches into a 42 inch Link-Belt 75 foot centers pan conveyor that conveys the material



The Management behind the Plant. Mr. Forsyth is on left end, Mr. Johnson is on right end and Mr. Trone is next to Mr. Johnson.

and discharges it into a 48 inch scalping screen. One section of this screen separates the six inch and over stone. This stone is chuted to a bin under the screen. End dump cars are loaded from this bin and taken up either one of two inclines as desired. One of these inclines leads to the kilns and the other direct to railroad cars.

The stone under six inches passes directly to a number 7½ Telsmith crusher and from there to either or both of two screens. The separation is controlled by a box. The oversize from these screens is the blast furnace and chemical stone. The ¾ and 2½ inch is separated out for sale to the chemical, building and highway markets and also supplies the material for the pulverizing plant.

Material for the pulverizing plant is taken by a pan conveyor to a Pennsylvania pulverizer. The product of this pulverizer is sold for use in glass making and for agricultural purposes. These products are stored in two cylindrical steel tanks each with a capacity of 800 tons. The products are removed from the tanks by screw conveyors which discharge to elevators, which in turn discharge to swinging arm screw conveyors that discharge direct to the cars.

The kiln stone is hauled up a 45 degree incline in steel dump cars by a double cylinder friction drum steam hoist and discharged to a transfer car, working the entire length of the kilns, which dumps to any desired kiln. There are fourteen 11x60 foot Keystone steel kilns with a combined capacity of 125 tons. The kilns are drawn twice in 24 hours and fired hourly. The lime fuel ratio is about three to one. The kilns are lined with General Refractories fire brick. Four men comprise the kiln force. Figuring one kiln idle most of the time an average of practically ten tons per kiln per day is maintained.

The plant was built in 1900 and the present company has been in control since 1905. J. C. Gittings is president of the company. R. K. Forsyth is vice-president and general manager. D. L. Warner is secretary and treasurer. C. H. Trone is assistant secretary and treasurer. F. A Johnson is superintendent. The extent of the business enjoyed by the Thomasville Stone and Lime Company is indicated by the fact that shipments are made as far as Lorain, Ohio.

Sodium Aluminate

Sodium aluminate having a high content of water-soluble alumina is obtained by igniting at the surface a uniform layer of an intimate mixture of fuel, aluminous material, and sodium carbonate, and causing the fuel to burn rapidly through the mass, whilst the latter, which is preferably moistened to avoid dust and to make it porous, is maintained in a relatively quiescent state. Crushed coal or coke or sawdust may be used as fuel. J. B. Barnitt—British Patent 264,823.)

Uses of Mica

The chief use of mica is in the electrical industries, states the United States Bureau of Mines Department of Commerce. One very widespread and important use is in the manufacture of the transmitter button, an integral part of the modern telephone instrument. Mica is also used in the manufacture of lightning arresters, condensers, commutators, and many special types of equipment. In addition to its use for the glazing of stoves and furnace, mica is manufactured into lamp chimneys, particularly for gas and gasoline lamps. For this purpose the mica must be clear, even splitting and flexible; little domestic mica is suitable for this purpose. Ground mica is utilized in the preparation of rolled roofing; it is dusted on the roofing material before rolling, and thereby prevents sticking of the rolls. A pound of mica has great covering power because of the flat shape of the thin particles. Ground mica is also used as a decorative material on wall paper and in special paints. It is occasionally employed as a facing for concrete to simulate granite. Coarsely-ground material is used for decoration and is sold under the name of Christmas-tree snow; the tonnage of material consumed in this market reaches an appreciable figure. Finely ground mica is used as a lubricant incorporated with greases, and also alone, especially as a tire powder. It is also used extensively as a rubber filler and many other minor industries use it to advantage.

Very flat and sound high-grade mica was previously in great demand for diaphragm use in phonographs. During the past year the demand in this market has shown a great decrease, due to competition with the radio and to the development of new types of phonographs which do not employ mica diaphragms. There has also been a constantly decreasing demand for mica chimneys on account of the replacement of gas by electric lights. The use of mica in the manufacture of spark plugs, which at one time was of much importance, has greatly decreased since the introduction of improved spark-plug porcelains.

The sudden and surprising development of the radio industry has created a market for very large quantities of mica, particularly in the smaller sizes of sheet material suitable for the manufacture of condensers. A certain amount of diaphragm mica has also been consumed in the manufacture of head phones and loud speakers, but this does not compensate for the decreased demand in the phonograph trade.

It is anticipated that the future expansion of the electrical industries will supply a market for large quantities of sheet mica and splittings. The projected electrification of certain railroad lines and the development of the oil-electric locomotive will also demand large quantities of this mineral.

PIT AND QUARRY FOREIGN DIGEST

Calcium Chloride and Cement

A series of experiments involving addition of amounts of calcium chloride to portland and blast furnace cement showed that the calcium salt is introduced without difficulty if the raw materials are previously dried at 180-200 degrees Cent. A very small quantity of calcium chloride has a very favorable effect upon the strength of blast furnace cement, probably caused by the formation of basic calcium chloride which probably has a great reactivity. Calcium chloride has a favorable effect upon the volume capacity. Cements prepared with calcium chloride undergo no unfavorable changes when subjected to actual cures. (O. F. Honus, Zement, March 24, 1927, pp. 223-226.)

X-Ray Patterns of Mullite and Sillimanite

X-Ray photographs of natural sillimanite, mullite, kaolin (ignited) and a synthetic aluminum silicate with 15 per cent of sodium tungstate at 1,350 degrees for 100 hours, revealed differences between the patterns of the sillimanite and the other samples examined. Since the differences depended on the relative spacing of the lines, they were sufficient for identification purposes. (Hyslop and Rooksby, J Soc. Glass Tech., 10, 412-415; B. A., 46, 219.)

X-Ray Analysis of Clays

The X-Ray examination of clays affords an accurate means of determining the relation between the size of the particles and the cohesive properties of the clay. The X-Ray (Kx) photographs of a variety of Russian clays, both plastic and rigid, including pure kaolin, were investigated. The presence of comparatively large crystals of quartz was detected. The kaolin, which was coarse-grained even when ground, gave a characteristic diagram, some lines of which persisted in all the clays, which was due to its space-lattice. The constants of this were calculated, and several possible structures discussed. Most of the clay consists of particles larger than 10^{-5} mm., i.e., the proportion of colloid is comparatively small, and the change in the X-Ray diagram must be due to the deformation of the space-lattice. (L. B. Strutinski, J. Russ. Phys. Chem. Soc., 58, 314-325; B. A., 46, 219.)

The Coloring Matter in Clays

The color of clays is due mainly to the presence of compounds of iron with tannic acid or some similar substance. The variations in color are not due, as heretofore assumed to the degree of dispersion of the iron, but to the fluctuating hydrogen or hydroxyl iron content. Tannin-iron solutions have characteristic colors depending upon the content of acids or bases. The intensity of the color is dependent upon the amount of iron present. Clays poor in iron become colored after addition of iron solution and the color reaches a maximum at a definite H-ion concentration. From these results, it may be inferred that the colors of the natural clays are due to the combination of tannin-like substances with the soluble iron content with fluctuating degrees of acidity and alkalinity. (O. Bartsdi, Sprechsaal, 60, 67-69.)

Rapid Hardening Cement and Concrete

The great advantages of the use of rapid hardening cements are obvious. In 1913 the first quick hardening cement was made by burning almost to fusion of an especially finely mixed calcareous slip poor in silica. The so-called "Kühl" cement gives excellent strength tests. These are not exceeded by aluminous cement. It has the advantage of being resistant to sea water and water containing sulphates. The rise in temperature on setting is considerable. The strength of these cements increases up to 1,000 kg. per sq. cm. after 360 days water cure. (Spindel, Beton u. Eisen, 26, 9-16.)

Sillimanite in Glass Works

The successful commercial use of sillimanite-clay refractories is cited in the case of a pot for opal glass, potettes, pot rings, port-hearth blocks, pot-furnace sieges and coatings for flues. (Cousen & Turner, J. Soc. Glass Tech., 10, 416-423; B. A., 46, 219.)

Thermal Analysis of Plaster

As an adjunct to the chemical analysis of plasters an apparatus for thermal analysis is described in which a thermometer dips into a truncated, conical, brass vessel containing the paste, surrounded by a calorimeter-jacket containing water, the temperature of which is adjusted electrically. Curves relating the temperature rise during setting and the time were determined. The apparatus enables control and classification of industrial plasters, according to their rates of hydration, to be obtained by measuring the beginning of setting, the rate of transformation into gypsum, and the composition and resistance. (Jolibois & Chassevent, Compt, rend., 184, 202-204, 1927; B. A., 46, 221.)

Artificial Stone

Silicic acid or material rich in this substance is melted with carbonates or other metallic salts decomposable with heat. For example, to form the substance MgCa (Si_2O_6) the equivalent amounts of calcium carbonate, magnesium carbonate and quartz are melted together. (J. Jakob—German Patent 437,187.)

Hydraulic Refractory Cement

By mixing one part of aluminous cement with two parts of bauxite calcined in a vertical kiln and ground, a cement was obtained which was capable of resisting high temperatures. The bauxite contained less than 12 per cent Fe_2O_3. The resulting cement is slow setting and quick hardening. The strength at three days is 2,030 lbs. per square inch for compression and 300 lbs. per sq. inch at tension. A refractory concrete may be obtained by using as aggregate old refractory bricks broken to a suitable size and unscreened. Washing the broken cement removes the very fine dust and prevents the dry aggregate from absorbing the water used in gauging the cement. Both cement and concrete have a very small contraction, about 1 per cent at 1,350 degrees Cent., and even less in some cases. Small specimens of concrete carried quickly from a temperature of 1,380 degrees Cent. to room temperature showed no cracks due to cooling. (M. P. Kestner, Chimie et Industrie and Concrete & Const., London, Eng., March, 1927, p. 194.)

Fineness of Cement

The weight of a cubic foot of cement may vary from 75 to 100 lbs., according to the fineness of grinding and the way it is packed. It is usually assumed that 90 lbs. per cubic foot is the weight, and this may be taken as approximately correct for loosely filled cement ground to 10 per cent residue on a 180 by 180 mesh sieve; 85 lbs. would be nearer the mark for at least one of the superior brands, as there is usually 2⅝ cubic feet per bag of 2 cwt., which gives 85.4 lbs. Some of the finer quick hardening cements will weigh less than this, as the finer ground the cement, the more it bulks. This does not mean that there is more cement for a given weight, but that the fine particles are separated by minute air cells which can be expelled by packing more tightly. The flour of the finely ground cement will, however, have a much higher cementing value than the heavier coarsely ground cement. It is quite safe to assume that the value of cement varies directly as the amount that passes the 180 by 180 mesh sieve. It may be said, therefore, that a 10 per cent residue is 90 per cent efficient, a 5 per cent residue is 95 per cent efficient and a 3 per cent residue is 97 per cent efficient. (G. McL. Gibson—The Structural Engineer, London, April, 1927, pp. 130-132.)

Silicic Acid With Membrane Filters

Silicic acid in colloidal state may be determined in two hours time with very great accuracy by means of colloidal filter mechanisms. Membrane filters, of 30 to 100 seconds, of a pore size of 2 microns and of 0.5 micron, and ultra filters are used. The method consists of precipitating the silicic acid with hydrochloric acid, heating to transform all hydrosol into gel, diluting and filtering. The method may be applied to various cements; clay, fireproof stone, quartzite, etc. (Heinrich Hart—Zement, March 31, 1927. 245-248.)

Dehydration of Borax

Borax is unaffected by 95 per cent or absolute alcohol at atmospheric temperature. With the application of heat, however, this condition is altered. Forty per cent alcohol has no effect, but dehydration with hot alcohol occurs with solutions stronger than this, gradually increasing with the strength of alcohol, until with 95 per cent, or above, 6.7 molecules of water are removed. The partly dehydrated mass is stable in air. The monohydrate can also be easily produced by heating with flue gases. The last molecule of water may be removed at red heat, but no economic advantage is obtained, because the anhydrous salt is hygroscopic. (M. A. Rakusin and D. A. Brodski—Chemiker Zeitung, *51*, 95-96, 1927.)

Anhydrous Silicas Containing Clays

After grinding a number of siliceous rocks, the portion passing through a 300 mesh sieve was treated by levigation or the amorphous silica dissolved out by means of caustic soda solution. In the unattacked residue, clays varying in amount from 9.4 to 28 per cent have been found, often associated with chalcedonite. Amorphous silica and silica obtained from ochre, diatoms, and infusoria also retain clay, the silica being anhydrous and deposited in an agglomerated form. Ochres are a mixture of globular silica, chalcedonite, clay and iron hydroxide. (A. P. Bigot—Compt. rend. *184*, 381-383. 1927.)

Improvements in Portland Cement

Comparative tests of the hardness and setting properties of Australian quick-hardening cement, "ferrocrete," and a slow hardening Portland cement are described. The latter contains 6.6 per cent Al_2O_3, and is supplied ground so that 95 per cent passes a 180 mesh sieve. Its tensile strength after seven days water cure is slightly greater than that of ferrocrete, but its compression is two-thirds as great. Concrete roads made of this cement may be used in three days. (H. J. Hawkes—Proc. Austral. Inst. Min. & Met. *63*, 57-61.)

Double Salts of Aluminum

Al, Zn, Fe, Mg, their oxides or mixtures of these metals or oxides are dissolved in dilute sulphuric or phosporic acids or in a mixture of both acids and the solution thus formed evaporated. The product of the process outlined exhibits properties which indicate a formula like $AlPO_4$, $3Al_2(SO_4)_3$, X H_2O. Solutions of these salts serve to increase the density of cements. G. Julien (French Patent 609, 361).

Porous Refractory Articles

Porous ceramic materials which resist shrinkage at high temperatures are obtained by the use of a clay substantially free from fluxing impurities such as iron oxide, titanium oxide, lime magnesia, alkalies and excess silica. A suitable clay is a kaolin melting not lower than Seger cone 32 and having two molecules of silica to one of alumina. According to one method of procedure, the clay is converted into a slip, mixed with half its weight of wood flour, and burned; the resulting porous grog is crushed, mixed with more kaolin and wood flour, molded and refired. (Carborundum Co., Ltd.—British Patent 266,185.)

Alkali Aluminates

Alkali aluminates are produced by wet grinding unroasted natural aluminferous material such as bauxite, and adding a solution of caustic alkali during or immediately after the grinding. The process may be effected in a ball mill, consisting of a long tube, one end of which is formed with perforations to which is applied a filtering layer enclosed in a perforated sleeve. The digestion with alkali is effected in the presence of an oxidizing agent such as hypochlorite, after which the mass is evaporated quickly until the temperature reaches 135 degrees C. It is kept at 135-140 degrees for an hour, then diluted and filtered, and the alumina is precipitated by carbonic acid in the known manner. (Kleinmann—British Patent 266,225.)

Lithopone

In the manufacture of lithopone, the precipitation of the barium sulphide and zinc sulphate solutions is effected in the presence of electrolytes or water-soluble compounds such as sodium or other soluble chloride, sodium or potassium sulphate, sulphuric acid, etc., equivalent in amount to 0.75-1 gm. of chlorine per liter of 25 degree Bé zinc sulphate solution at 20 degrees C. The crude pulp is filter pressed and dried so as to contain 4-10 per cent of moisture, and then calcined at a temperature high enough to give the desired covering power but lower than will materially affect its light resistance. Suitable calcination temperatures range from 725-800 degrees C., and the operation is carried out in an apparatus of the vertical retort type. The finished lithopone has a predetermined degree of alkalinity. (G. G. Breyer and C. W. Farber—British Patent 265,550.)

Artificial Stone Masses

Slate powder (40-70 per cent), rubber (15-20 per cent), bitumen (2-10 per cent), sulphur and due (13-25 per cent) are mixed, the mixture is molded and vulcanized. The mass is especially suitable for insulating devices. (C. Pickstone—German Patent 439,585.)

Refractory Substances from Clays

Refractory articles composed of crystals embedded in a glassy matrix are obtained by fusing suitable substances, casting and by annealing. As raw materials aluminous-siliceous mixtures, pure alumina, magnesia, zirconia, etc., may be used. Mixtures of kaolin with diaspore clay or bauxite are particularly suitable. The materials are fused in an electric furnace and cast in iron or sand molds. Hollow articles may be obtained by allowing the material partially to solidify in an iron mold, and pouring out the remaining molten material. (R. Haddan—British Patent 265,847.)

Treating Phosphates

The process of preparing alkali dicalcium phosphate by calcining a mixture of crude phosphate, alkali carbonate and silicic acid is carried out in the presence of steam, whereby the unfavorable action of fluorides or gypsum, if present, is avoided. The addition to the mixture of small quantities of reducing substances may also be advantageous, by facilitating decomposition of gypsum. (Rhenania—Kunheim Verein Chemischer Fabriken Akt.-Ges. British Patent 265,197.)

Aluminous Cements

Aluminous cements are obtained by heating the raw materials for at least 30 hours to a temperature between 1150 degrees C. and the melting point of the mixture, and preferably cooling the product slowly over a further period of at least 30 hours. A preheating treatment lasting 24 hours or more may precede the heating process. The raw materials may be comparatively coarsely ground. (G. Hertzka—British Patent 265,494.)

Heavy Spar and Cement

A mineral containing heavy spar and calcium carbonate is calcined and the product slaked with water. The heavy spar is separated from the slaked lime and other impurities by decantation with water, using HcL if necessary. The separated lime and impurities can be used as a paint or as a raw material in cement manufacture. (K. Ebers—British Patent 246,498.)

Chamotte and Clay Slips for Refractory Brick

Binding clay is liquefied by the addition of water and an alkali, and the concentrated alkaline clay slip is mixed with sufficient grog to produce a noncastable mass, which is molded under pressure, to insure close contact of the grains, dried, and burnt, producing articles with a high binding and compression strength. Blocks of low plasticity are obtained by diluting the clay slip with water, mixing this with the grog and moldng, drying and burning. (Scheidhauer & Giessing A.-G.—British Patent 253,947.)

APPLYING SCIENCE AND ENGINEERING TO THE LIME INDUSTRY

By V. J. Azbe*

LIME is a most interesting substance, but, due to only superficial familiarity on the part of many, this is not appreciated and in consequence abused. Limestone lends itself readily—too readily—to conversion into lime, therefore the most crude methods can be used and are used in the burning. Limestone to many people is a common rock and hardly worthy of careful study. The actions which take place during the burning period are known to extremely few; what methods to use to regulate these actions is known to even a lesser number. It is now fairly well known that the rate of hydration, rate of settling, availability, plasticity, volume of water, contamination with impurities and color are all greatly dependent upon the method of burning. There are good opportunities for improvement and a few manufacturers are making very serious efforts to manufacture a product having desirable characteristics, but many will never do so until they are forced into it by competition, and of those who make attempts none will succeed unless they call science and sound engineering to their aid.

Sometimes apparently serious attempts are made to improve the product, to increase the output or to better the efficiency, but often in such cases men are put in charge who are not in sympathy with the experiments or lack the necessary knowledge, or probably are saturated with faulty ideas prevailing in every industry of long standing, of which the lime industry appears to have more than its quota. Their efforts are half-hearted and if there are no immediate results the attempts are abandoned.

It is a sad commentary that a large number of lime manufacturers in this country still employ the same crude uneconomical methods that were used as far back as the memory of the oldest lime burner reaches. The lime industry as a whole has not made the same progress in the past twenty-five years that many other industries have. This is only partly excusable. The industry is small and the gains to be derived are not very apparent to many. Some producers make strenuous efforts at improvements, but, only with a few such workers, experience accumulates slowly. Industrial progress is the accumulated experience and knowledge of many.

Improvement is possible, but it may be slow in coming and persistence is necessary. This is demonstrated by Figures 1 and 2, which show results obtained by a plant operating four kilns continuously for the entire period of three years. All the improvements were of a more minor nature; no great kiln changes. In these three years of effort the lime output per ton of coal was increased 36 per cent and the capacity of kiln 41 per cent. Figures 3 and 4 show the progress in a different direction. The first illustration shows how the kilns emitted smoke before attempts at improvement were started. Everyone will agree that lime of good appearance cannot be obtained from kilns smoking as badly as those shown in this half-tone. Nor can good lime of consistent characteristics be obtained under these conditions. The second illus-

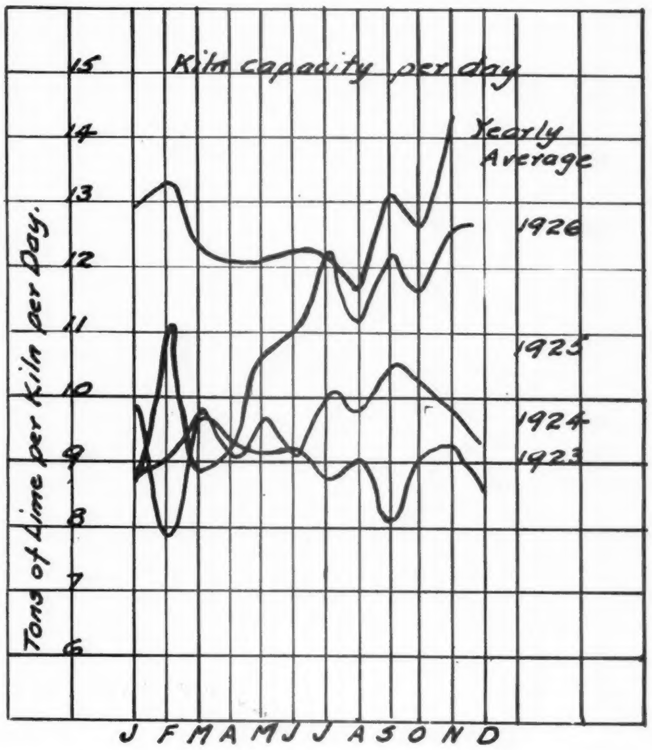


Figure 1—Kiln Capacity Per Day

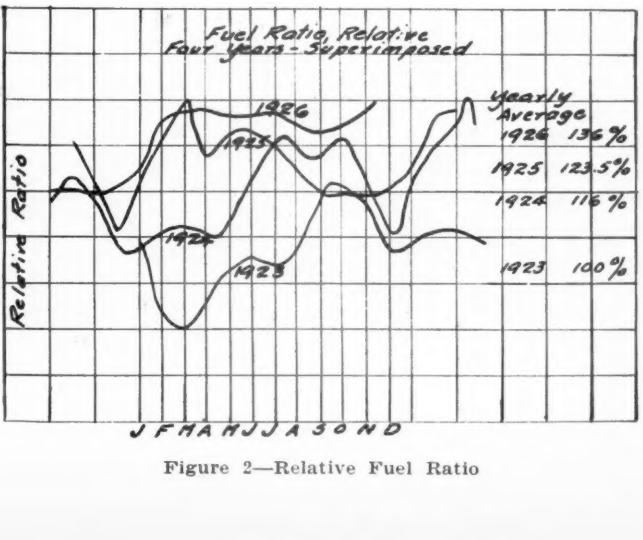


Figure 2—Relative Fuel Ratio

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*Presented before the Symposium on Lime at Richmond, Virginia, April 14, 1927.

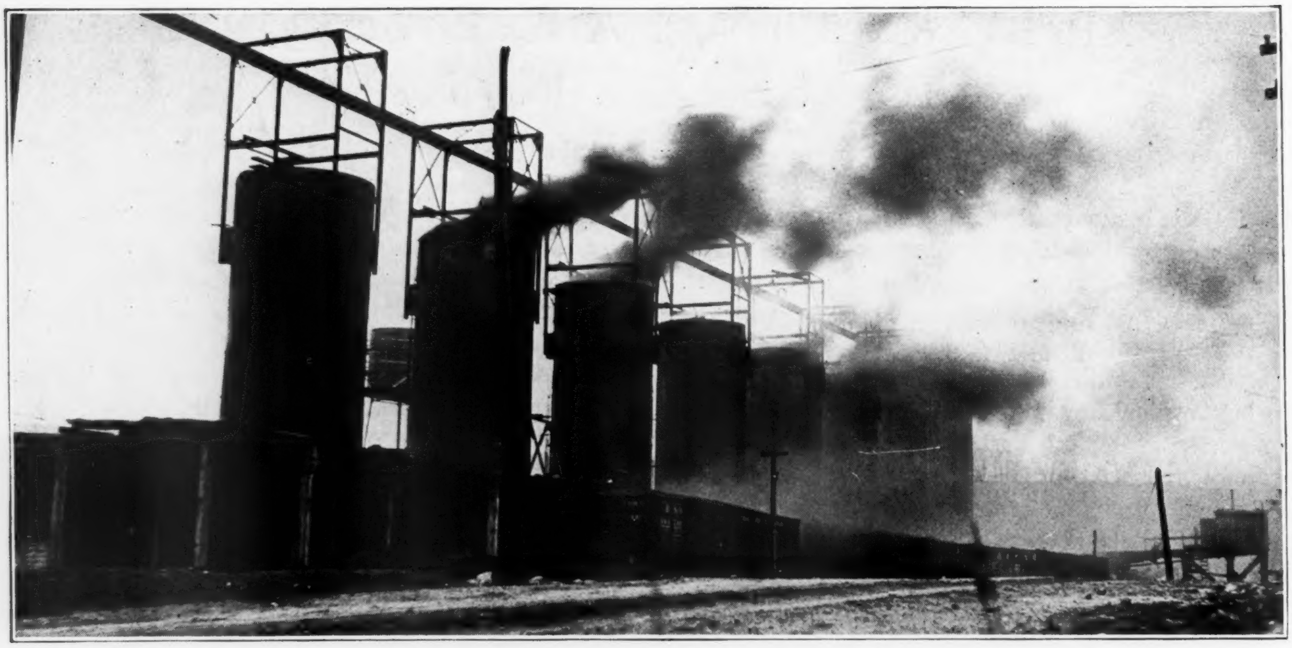


Figure 3—Lime Kilns With Smoke From Old Burning Methods

tration, figure 4, shows the appearance of the kilns after the improved methods had been adopted.

All lime and limestone is crystalline. It may present an amorphous appearance; it may not even present any crystalline characteristics when highly magnified by the petrographic microscope, but still, in its ultimate form, it is crystalline, the mass being composed of cells having definite arrangement and of definite size. The atoms making up the molecules of lime or limestone are aggregated in a systematic manner so as to form unit cells. These cells are the smallest particles of lime or limestone that can exist. Figure 5 shows calcium carbonate and calcium oxide unit cells drawn to scale, magnified four quadrillion times. That the cells have this form and that they are of this size can be proven with great accuracy by the use of the x-ray defraction apparatus, a new instrument of great promise for the scientific student of lime.

A unit cell of limestone is not very large, the edge dimension as shown being 6.36 Angstrom units. This unit is the inch of the physicist dealing with substances submicroscopic in size and there are a little over 250 million of these units to an inch. Therefore the number of these unit cells of limestone lined up shoulder to shoulder in a distance of one inch is 39,300,000. These cells are so extremely minute that those contained in only a cubic inch of limestone placed end to end in a line would reach around the world about one million times. Still it is the arrangement of these infinitely small cells that determines the properties of lime.

It is well known that the chemical analysis of lime does not always indicate the special purposes

Figure 4—Lime Kilns of Figure 3 With Improved Burning Methods

for which the lime may be of service. There are many lime uses and important properties which have no relation to the chemical analysis. In many instances, it is entirely the physical and not the chemical composition that will determine the behavior of the substance. The chemical analysis will show that there are brick-unit cells, but how these cells are arranged, what system of architecture is followed, is a different story. Taking plasticity as an example, that one lime is plastic and the other not, is more a question of the arrangement of these unit cells than the particular kind of cells.

During the burning of limestone, numerous changes occur in the lime structure. What exactly happens we, in a way, can deduce from the makeup of the original and final products. There is no doubt, however, that there are also other changes which at the present we do not suspect. The changes that take place of which we have a fair assurance are:

1. The heat causes so great molecular activity that the CO_3 ion is broken up, the CO_2 molecule escaping, the remaining O atom entering the CaO structure.

2. The cell shape changes from rhombohedral for $CaCO_3$ to cubic for CaO.

3. The old cell arrangement is entirely destroyed and new cells are formed. Each $CaCO_3$ cell contains two complete molecules, while each CaO cell contains four molecules.

4. The dimensions of the old cell were 6.36 Angstrom units, while the dimensions of the CaO cell are only 4.79 Angstrom units.

5. The number of new cells is exactly half the number of the old $CaCO_3$ cells.

6. The new cell is considerably heavier than the old cell. This, however, will not be apparent in soft burned lime, due to formation of extremely minute invisible voids.

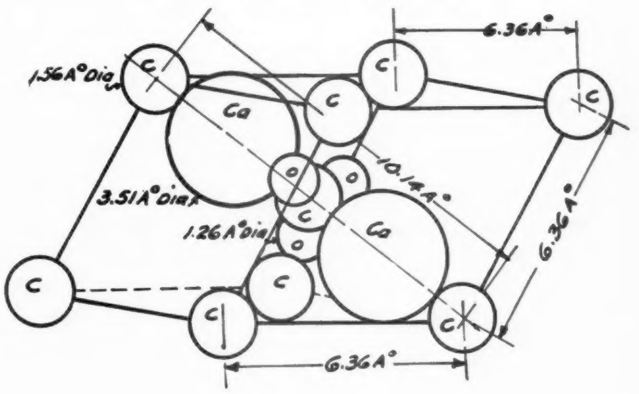
7. When lime is very hard burned, the unit cells of the CaO will not change in size or shape. They will, however, aggregate, the voids will fill out, the lump will shrink and become perceptibly heavier.

8. Occupied space, that is, space under atomic influence in calcium oxide, is 43.4 per cent of that in calcium carbonate. In other words, soft burned unshrunk lime contains 56.6 per cent voids. This is more than the loss of weight due to burning; in fact, the loss of weight has little to do with it.

9. While the specific gravity of $CaCO_3$ is 2.71, the apparent gravity of soft burned lime is only 1.5. If this lime is extremely hard burned, the cells will assemble up against one another. There will be no voids. The specimen will shrink to less than half the original size and the specific gravity will increase up to the maximum or 3.4.

10. The CaO cell is quite self-contained, not dependent so much upon neighbor cells, which accounts for the slight change when lime is soft burned.

Unit Cell of Calcium Carbonate



Unit Cell of Calcium Oxide

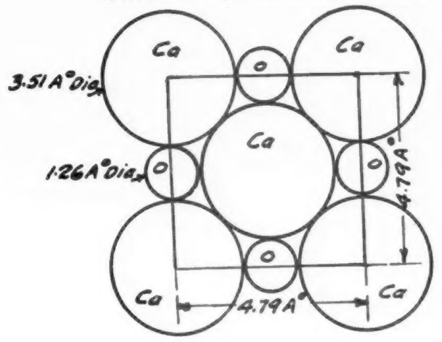


Figure 5

11. The spaces between the cells in soft burned lime are wider than the width of the cells. They are several times wider than the molecule of water, also considerably wider than the molecule of CO_2. As the lime is hard burned, the space width is reduced and water molecules enter with greater and greater difficulty.

12. During hydration, the CaO cells break down in four times the number of $Ca(OH)_2$ cells.

13. The dimension of a $Ca(OH)_2$ cell is 3.52 Angstrom units as compared with 4.79 Angstrom, units for CaO. The four cells, however, occupy a great deal more space than the original CaO cell.

14. If the carbonate was soft burned, oxide while hydrating will find spaces already existing for it to expand into.

15. If the lime was hard burned, the spaces were reduced in size at points or entirely eliminated at other points. The hydrate would have greater difficulty to expand and as a consequence there would be either localized or general closer packing of the cells which would tend to give the lime different physical properties.

16. The above findings are all independent of the action that impurities may have.

Haslam in his studies of lime comes to the conclusion that "The temperature at which a limestone is burned has an important bearing upon the

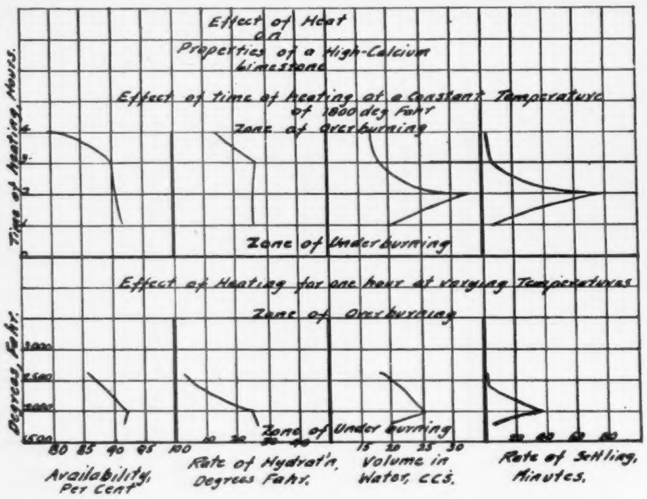


Figure 6

properties of the resultant hydrates. Time of burning is of equal or greater importance."

Mathers of Indiana University says: "The temperature at which quicklime is produced largely determines the hydrating properties of lime and the rate of hydration, in turn, seems to have an important influence upon properties of hydrates."

Figure 6 gives some results of the writer's experiments in effect of heat on some properties of lime. It is plainly noticeable that both time and temperature are important. At least, to the writer's mind, there is little doubt but that lime at high temperatures while not fused is soft. This softness means that the cells flow; that atoms are able to capitalize upon their attraction for each other; that there is a general molecular activity tending for the cells to aggregate into larger and larger, denser and denser groups. In plain words one would say the lime has shrunk. Figure 7 shows the shrinkage plainly. "A" is a one-inch cube of limestone and "B" is softly burned lime. As limestone this cube had the same size as "A" and as lime the cube had lost practically no volume. Again, "C" as limestone had also the same size as "Z" but, having been burned for a long time and at a high temperature, it is 40 per cent smaller than the cube was as limestone.

The writer in his studies of lime kilns found that temperatures as high as 3,000 degrees Fahr. and 2,600 degrees Fahr. were quite common. Flame temperatures of 2,000 degrees Fahr. which both Haslam and Mathers seem to prefer are not obtained in any kilns except the wood fired type and with these the high temperature is due to the diluting effect of great quantities of water vapor coming from the wood.

Regarding the length of time of burning, the lime usually remains in the ordinary kiln over two days and in some cases as many as seven days. The length of time it is in the burning zone may be about one-third to one-half of this time. When the material gets into the hottest zone, where the temperature is 2,400 to 2,600 degrees Fahr., the material is all lime and it remains in this zone for a period of from two to eight hours. Some kilns are drawn every two hours and others every eight hours but the majority are drawn either every four or six hours. Another question is the un-uniformity of material. Almost all vertical kiln stone may vary in size from 4 to 12 inches. Under these conditions one lump will have nine square inches of surface, the other 864 square inches; one will contain 64 cubic inches, the other 1,728. The larger stone will require 27 times the heat of the smaller but will have only nine times the surface. Then to burn the core in the larger lump, the heat will have to pass through six inches of insulating lime while in the small only through two inches. It is therefore impossible for the larger lump to have the same properties after burning as the smaller even though different portions of the larger lump will have different characteristics, having been burned at different temperatures for various periods.

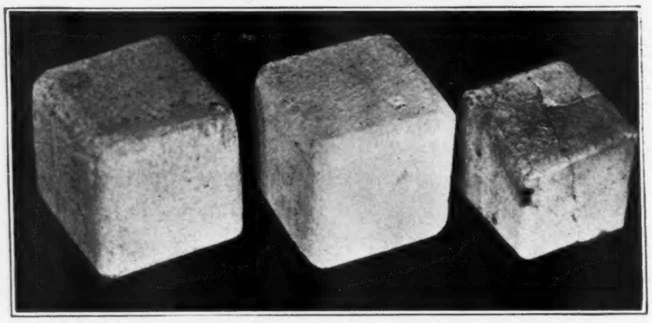

A B C

Figure 7

The flame temperature variability is another problem. The lump of lime that passes down through the center of the kiln shaft will not be as hard burned as the lump that passes the furnace eye. The gas flow also is unequal. There is a stronger flow upwards in certain channels than in others. Where the flow of gas is strongest the limestone begins to decompose sooner. If the drawing off was exactly proportional to the lime made in different kiln sections, then this last variability would not be serious but the tendency is to draw most lime where the least lime is made. Again it is hard to get the lime down from the kiln shaft corners and sides without the underburned center falling.

Yet another variability is in the firing, and the fact that it averages itself over the period between two draws does not fully correct the damage.

There is still another possibility of harmfully affecting the lime quality, namely by contamination. That lime in kilns can breathe, inhale as well as exhale, would appear quite puzzling to many but nevertheless this is easily possible and is very often responsible for poor lime quality. Ordinarily, the lime exhales, the CO_2 gas given off by the decomposing carbonate flowing outward through the surface. This is demonstrated by the log in the heating curve of Figure 8. If, for any reason, the temperature drops below that necessary for decomposition, the CO_2 within the lump will be reabsorbed, that is, it will return into the lime and again make carbonate. This also is demonstrated by Figure 8 in the log of the cooling curve. When this happens a vacuum occurs in the lump and to satisfy this vacuum gas from the outside of the lump rushes in and if this gas contains impurities, whatever they may be, tar vapors, fine particles of smoke, sulphur dioxide, arsenic compounds, they, to a degree, will be absorbed or just deposited, thus contaminating the lime, often to such an extent as to prevent its use for special purposes.

It now becomes evident that the ordinary kiln, as ordinarily operated, cannot give a lime that is satisfactory in a great many respects. It is impossible to get low temperatures except at the expense of efficiency if resort is not taken to use special and only lately recommended methods of operation. Figure 9 is a diagrammatical sketch showing roughly what is needed if control over temperatures in a lime kiln is to be exercised.

1. It is essential that stone fed to the kiln is fairly uniform in size and this is preferred to be as small as is permissible from practical operating standpoints.
2. The producer gas and air must be supplied to the kiln at a definite rate. Both must be constant. Any variation will result in temperature fluctuations as well as in the lowering of the kiln efficiency.
3. The gas and the air should be thoroughly mixed before they enter the kiln, otherwise there will be stratification into streams of variable oxygen content. This will in turn result in variable temperatures through the kiln and will also lower the kiln capacity.
4. The kiln must be operated at a definite rate proportional to the shaft cross section, otherwise there will be gas streams of unequal velocity, resulting in lime being burned higher in certain sections of the kiln than in others.
5. It is preferable to have gas and air under slight pressure and the kiln eye choked down, to assure fair velocity of gases when entering kiln and their penetration to the kiln center.
6. The kiln must be so arranged by means of properly located piers and punching doors that, when drawing, the kiln can be properly punched and more lime removed from above the eyes and corners than from the center.
7. The drawing should be frequent, preferably every two hours, and the same amount of lime should be drawn during each draw. This is entirely possible if the gas and air are supplied to the kilns at constant rates.
8. Hand firing is too inconstant to be even considered; probably the best is a gas producer of such type that the volatile matter will be driven off at a slow, steady rate. Low gasification per square foot

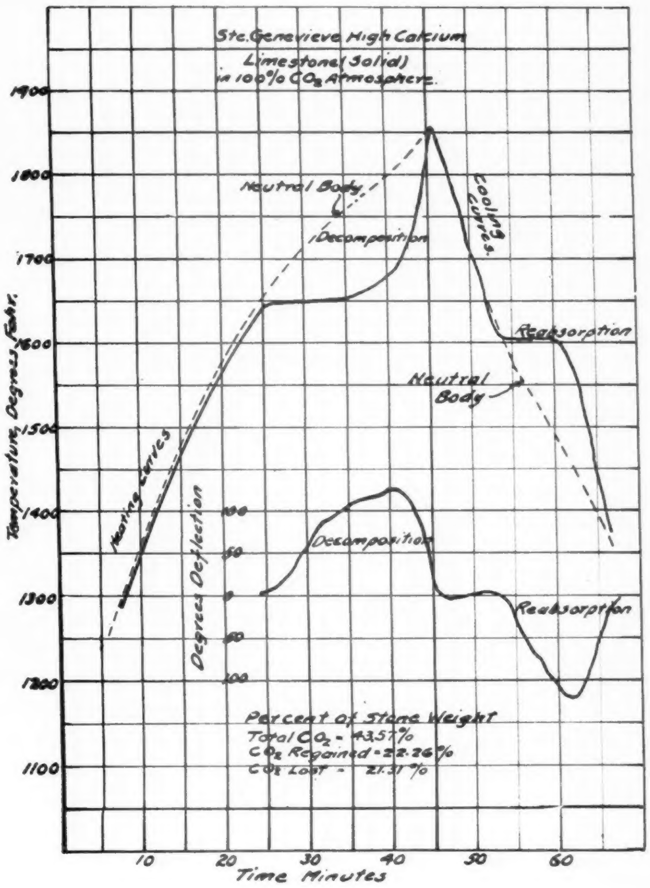


Figure 8

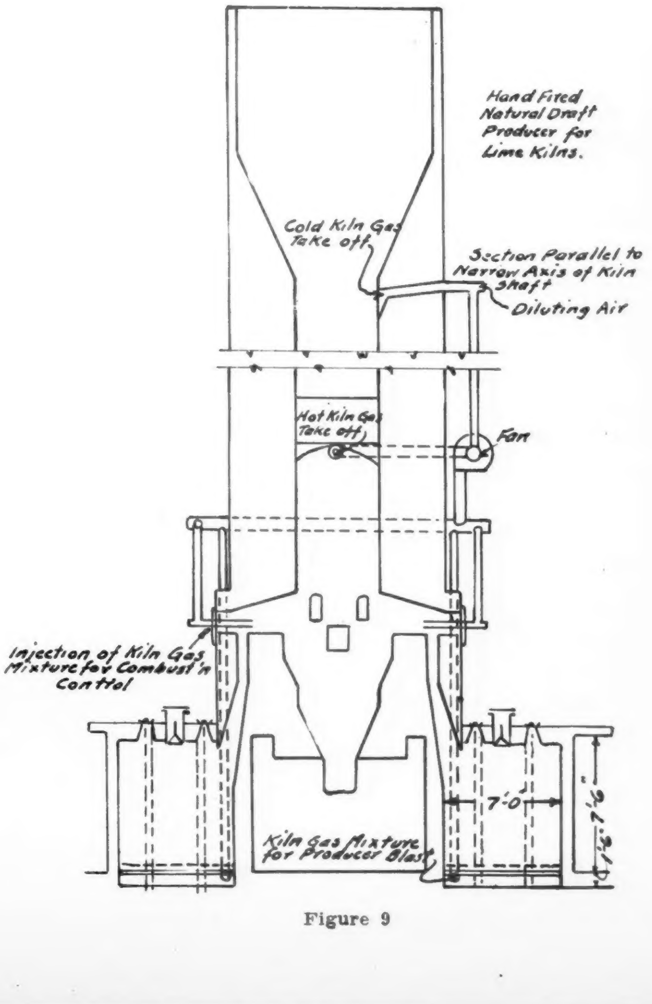


Figure 9

of grate surface is essential excepting only when automatic producers are used.

9. While drawing there should be no interruption in firing. Any cooling resulting from interruption may cause recarbonization and possible contamination.

10. Kiln temperatures should be controlled by dilution with waste gases. If cold kiln gas is employed, this gas will have to be reheated, causing a waste of heat.

11. The preferable location for removal of waste gas is immediately above the decomposition zone where the gas is still hot. If hot gas is recirculated, a very large amount may be used, thus very effectively reducing kiln temperatures.

12. The blower or fan circulating the gas should be so arranged that it handles both air and recirculation gas mixed, thus lowering temperature of the gas.

13. When desiring to hard burn the lime, the recirculating gas amount should be reduced, thus increasing the kiln temperatures. It also could be accomplished by drawing at a rate permitting the lime to remain longer in the kiln, or both systems may be employed.

14. When temperatures should be lowered for soft burning of lime, the decomposition zone should extend to greater heights, due to the lowering of temperature difference.

15. If care is taken that the above essentials are satisfied and if the kiln is so operated that high CO_2, low O and no CO is found in the waste gas and if the kiln is guarded against loss of heat by radiation, then the kiln capacity and efficiency as well as lime quality will be good.

Road Show Goes to Cleveland

After carefully considering invitations from several cities, it has been decided to hold the 1928 Convention and Road Show of the American Road Builders' Association in Cleveland, Ohio. The exposition will be held in Cleveland's Auditorium and Annex from January 9th to 13th, 1928.

The building in Cleveland has advantages for this purpose over the Coliseum, Chicago, where the show was formerly held. There is available 45 per cent more area with facilities such as railroad tracks adjacent to the exhibition building. With less expense to the exhbtior, a more satisfactory exhibit may be made and more space secured than in previous years. This lack of space during the past few years has been a drawback to the many exhibitors who have desired to show improved machines and materials but they were not able to exhibit in Chicago because of the restricted space.

An arrangement has been made with the convention board of the Cleveland Chamber of Commerce, by which all hotel reservations will be made through a central bureau. Definite and detailed arrangements as to how reservations should be made will be made public later.

The Association at the present time is organizing a division of County officials and one of the features of the 1928 Convention will be County Officials' Day, when papers and discussion covering the problems of county officials will be presented. Governors' Day will also be observed and it is expected that a large number of Governors from various states will be in attendance.

British Quarry Managers To Hold Annual Conference

The British Quarry Managers will hold their annual conference and exhibition of quarrying plant, machinery etc., from June 27th to July 2nd at Harrogate, Yorkshire, England. The great success of the first Exhibition, held last year, is likely to be followed by an even more successful Exhibition this year, many of the firms having taken larger spaces in which to exhibit their machinery. Last year, over 500 tons of machinery were on view at the Exhibition, and this figure will be exceeded this year. Crude oil engines are again to be a leading feature, these engines having become increasingly popular of late years as power suppliers in quarries.

There are a few new features introduced in the Conference program, the most revolutionary being that there will be no long papers read. A number of lecturettes is to take the place of the papers, each lecturer being restricted to eight minutes. Time will be allowed for discussion and verbatim reports of the lecturettes and discussions will be published.

The tentative program is as follows:—

Monday June 27th. Opening day.

Evening. Civic reception by his Worship the Mayor of Harrogate, Lady Mayoress and Town Clerk.

Tuesday June 28th. Morning. Official opening of the Exhibition.

Afternoon. Meetings, Annual General Meeting.

Evening. Annual Banquet.

Wednesday June 29th. Morning. Lecturettes and Discussion.

Afternoon. Garden Party in the Exhibition Grounds.

Evening. Concerts followed by a dance.

Thursday June 30th. Morning. Special session for revision of Rules.

Afternoon. Lecturettes and Discussion. Golf and Tennis Tournaments.

Evening. Presentation of Prizes. Guests of the Trade Members Section to Dinner.

Friday July 1st. Morning. Visit to Quarries and Works.

Afternoon. Final Meetings.

Evening. Dance.

Saturday July 2nd. Conclusion of conference.

AN X-RAY STUDY OF LIMES

By Marie Farnsworth

ALTHOUGH lime burning is one of the oldest known industries, there is very little scientific information in regard to it and especially is there very little information in regard to plasticity. Some limestones will make a good finishing hydrate and other limestones with almost the same chemical composition will not; two limestones of very different chemical composition will often give equally good hydrates. Since the underlying cause does not seem to be chemical, it is natural to seek a physical explanation of this difference and, therefore, an X-ray study of the basic materials involved and of hydrates of different plasticities was undertaken.

X-Ray Methods

Owing to the nature of the materials to be studied, the pictures were limited to powder photographs as developed by Debye-Scherrer and independently by Hull. The pictures were taken on a multiple diffraction apparatus (Figure 1) in the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology. The tube employed was the usual Coolidge water-cooled molybdenum anode type operated at 15 milli-amperes and 30,000 volts R.M.S. The x-rays were restricted by means of two slits, 0.5 mm. wide and 4 inches apart in a copper cylinder with a lead end. A zirconium oxide filter, free from hafnium, was placed over the slit near the target. This practically eliminated from the primary beam the white (general) radiation, and the characteristic molybdenum β and γ rays. The diffraction pattern, as recorded on the photographic film, was therefore caused by the molybdenum α-doublet. The cassettes served not only as holders for the films but also as holders for the specimens. The powdered specimens (finer than 200 mesh) were packed into thin-walled special tubes of glass, free from heavy metals, of about 1/32 inch inside diameter, and sealed with collodion so that the specimen would not be affected by air or moisture. A septum divided the cassette so that two different substances could be recorded directly on the same film.

The film (1⅞x16 inches) was automatically held on a semi-circle of 13 centimeter radius at whose center the specimen was fixed. The use of a semicircle, rather than a quadrant, for powder work permits measurement of the pattern without reference to the trace of the zero beam. The zero beam passed through the sample and on a brass stoppiece, enclosed by a sheet brass baffle to prevent secondary radiation from reaching the film. Sheet aluminium (0.012 inch thick) was used on the sample side of the film to filter out light rays and to pass the x-rays. A calcium tungstate intensifying screen was used on the side of the film farthest from the x-ray beam to cut down the time of exposure. In this manner the diffraction pattern is recorded as a series of lines on the film. The interpretation of various patterns will be given later.

Preliminary Experiments

Preliminary experiments were carried out using ordinary commercial samples. The samples were contained in small glass tubes; a plug of cotton was put in the middle and a sample of low plasticity was put in one end and a sample of high plasticity in the other end. If two oxides or two hydrates were employed, in all cases extra lines not occurring for the sample of high plasticity occurred on the film of the sample of low plasticity. If two carbonates were used (provided they had approximately the same chemical composition) no difference in lines was observed. These photographs were very complicated, as there were lines due to magnesium and calcium as well as to the impurities, so that it seemed almost impossible to analyze them completely. Therefore it was decided to first restrict the study to simpler substances and for this reason only a very pure sample of white marble and

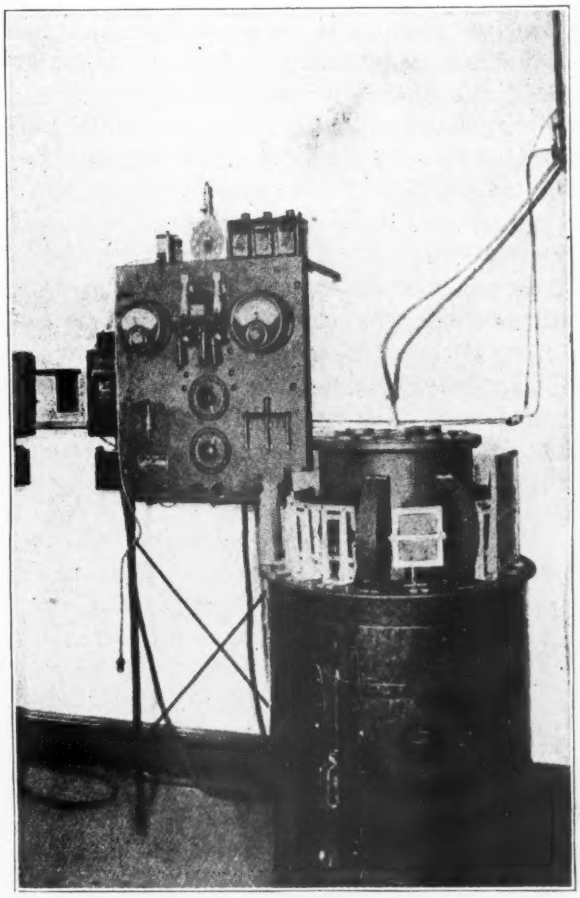


Figure 1—Multiple X-Ray Spectograph

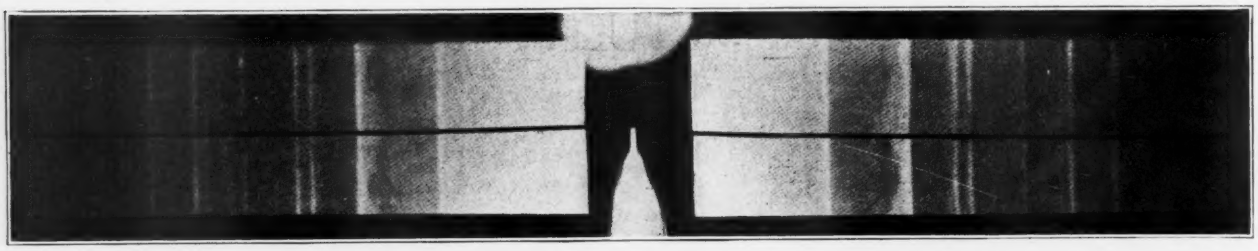


Figure 2—CaO From Marble Burned in a Vacuum at 1800 Degrees Fahr.

Baker's analyzed C. P. precipitated calcium carbonate were employed.

Calcination of Samples

It has recently been found by Haslam and Hermann that the time and temperature of burning has a great influence on the resulting properties of lime and that from the same sample of limestone either a plastic or non-plastic hydrate would result according to the temperature and length of time of burning. These observations were found to be true for marble and precipitated calcium carbonate. The samples were burned in an electric furnace which could be held constant within about 10 degrees Fahr. After the desired temperature was reached and the furnace had had time to heat evenly, five pounds of the prepared limestone was dumped into the clay-graphite, porcelain lined crucible. This cooled down the furnace, and a maximum time of thirty minutes was required to bring the furnace and its contents back to the desired temperature. The sample was heated in the furnace for three hours before the power was shut off and it was allowed to cool to room temperature.

The size of stone employed was ¾ to 1 inch. In order that the burning of the finely divided calcium carbonate would be as nearly analogous to the marble as possible, it was made into lumps of approximately the same size by means of dextrin. During the burning the dextrin was burned out but the lumps still stuck together. At the lower temperatures there was some evidence of free carbon but in no case did lines due to carbon appear on the films. After cooling it was removed and ground to pass through a 10-mesh screen and then put into tightly covered tin cans to prevent air slacking. All runs were made in the same manner.

Hydration of Samples

For hydrating, a weighed amount of the lime was placed in a tin can set into a basin of running cold water. Enough water was measured out to hydrate the lime, with 50 per cent excess to take care of evaporation. The water was added slowly and the mass was vigorously stirred to prevent the formation of lumps and local over-heating. This method produced a dry hydrate.

Determination of Plasticity

The plasticity of the various samples was tested according to the standard method of the American Society for Testing Materials. Three hundred grams of lime were hydrated and, after aging for one day, were formed into a putty by adding a sufficient quantity of water. This putty was allowed to soak for not more than 24 hours nor less than 16. It was then molded in a rubber ring such as is used with a Vicat needle, resting the specimen on a glass plate. The needle used was a modified form of Vicat needle, 12.5 mm. in diameter and weighing 30 grams, made from aluminium tubing. The lower end was closed without shoulder or curvature, and the tube loaded with shot to the specified weight. It was mounted in a Vicat needle stand; the initial reading was taken with the bottom of the needle in contact with the surface of the sample; the final reading was taken 30 seconds after the plunger was released. A penetration of 20 mm. with a permissible variation of 5 mm. on either side was considered standard. If the penetration was less than standard, the sample was removed from the mold, mixed with more water, and retested. If the penetration was more than standard, the sample was discarded and a new one prepared.

The sample was then ready to test for plasticity. This was conducted on an improved form of the Emley plasticimeter, the constants of which were as follows:

Absorption of base plate—20 to 25 per cent.

Dimension of base plate—1 inch in thickness by 4 inches in diameter.

Dimensions of disk—1/32 inch in thickness by 3 inches in diameter.

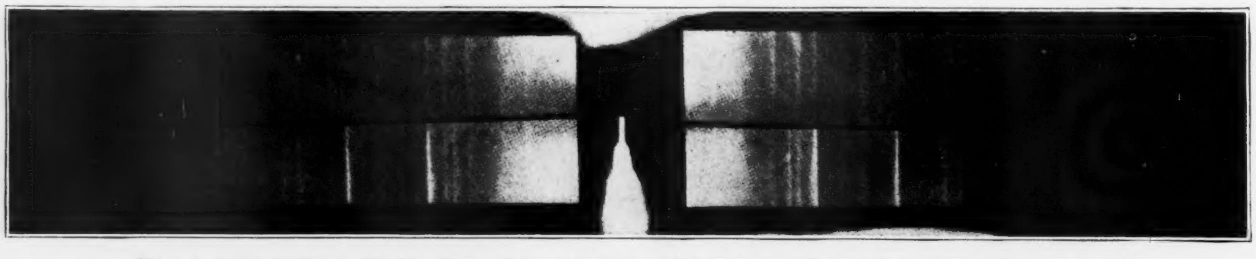


Figure 3—CaO From Marble Burned in Air; Top, 1800 Degrees Fahr.; Bottom, 2200 Degrees Fahr.

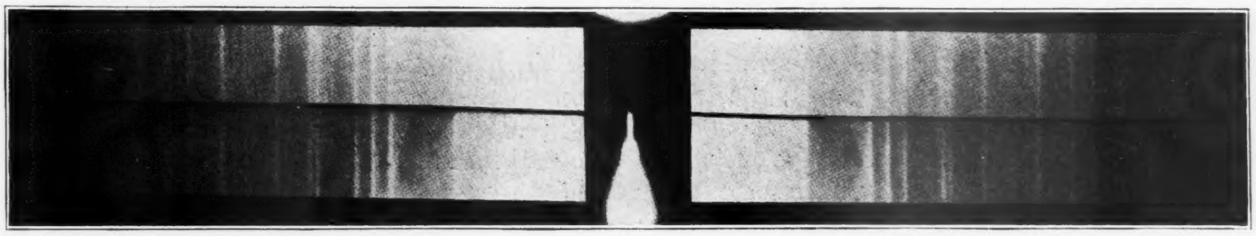


Figure 4—$Ca(OH)_2$ from Marble Burned in Vacuum; Top, 1800 Degrees Fahr. Bottom, 2400 Degrees Fahr.

Speed of vertical shaft—one revolution in 6 minutes, 40 seconds.

Upward movement of base plate—1/13 inch per revolution.

Torque on disk when bob reading is 100—14,400 gcc.m.

The rubber ring previously mentioned was lubricated with a thin film of water placed on a porcelain base plate filled with the paste and struck off level. The mold was removed by raising it vertically without distorting the paste. The base plate and paste were placed in the instrument and the carriage turned up by hand until the surface of the paste was in contact with the disk and the distance between the disk and the top of the base plate was 1¼ inches. The carriage was then thrown into gear and the motor started exactly 120 seconds after the first portion of the paste had been put into the mold. The time when the first portion of the paste was put into the mould was recorded as zero time. The scale reading was recorded every minute until the test was completed.

The test was considered complete when (a) the scale reading reached 100, (b) any reading was less than the one before, (c) the scale reading remained constant for three consecutive readings (2 minutes) and the specimen had visibly ruptured or broken loose from the base plate. The time and scale reading at the end of the experiment were noted. The plasticity figure was calculated from the formula $P = \sqrt{F^2 + 10\ T^2}$, in which P is the plasticity figure, F is the scale reading at the end of the experiment, and T is the time in minutes from the instant the first portion of the paste was put into the mold to the end of the test. After each test the porcelain base plate was washed with hot water, treated with dilute hydrochloric acid to remove any lime from the surface pores, washed again to remove the acid, dried by heating to about 100 degrees Cent. and cooled to room temperature before it was used again. The results are shown in Table I.

TABLE I

Sample	Temperature of Burning Deg. Fahr.	Plasticity $P = \sqrt{F^2 + 10\ T^2}$
Marble	1600	not plastic—very sandy
Marble	1800	94
Marble	2000	192
Marble	2200	198
$CaCO_3$	1800	157
$CaCO_3$	2000	166
$CaCO_3$	2200	295

The sample of marble burned at 1600 was very clearly not completely burned. Although the sample behaved like oxide in falling into small lumps, these small lumps were hard and obviously consisted mostly of marble. This was verified by x-ray photographs.

Calcination in a Vacuum

In order to test especially the effect of carbon dioxide vapor pressure on the samples, samples of marble were also burned in a graphite vacuum furnace. The crucibles for this furnace were quite small, so only about 30 grams could be burned at one time. The samples were burned as nearly like those burned in air as possible; as the sample could not be put in the furnace after it had been brought up to temperature, the sample was put into the cold furnace, about ½ hour was allowed for the furnace to come to the correct temperature, and the sample was then heated for 2½ hours at that temperature. The sample was allowed to cool and hydrated in identically the same manner as the air burned samples. Unfortunately no vacuum furnace was available that would burn large enough samples for testing the plasticity on the Emley plasticimeter. Therefore the Carson blotter test was employed and the samples could only be qualitatively compared among themselves and with the samples burned in air.

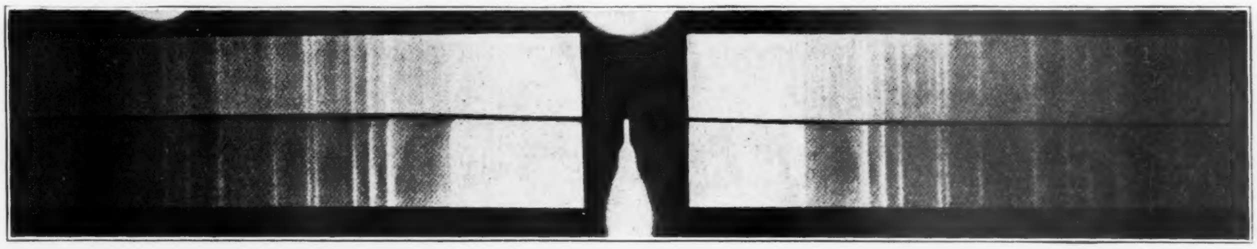


Figure 5—$Ca(OH)_2$ from C. P. $CaCo_3$; Top, 1800 Degrees Fahr.; Bottom, 2200 Degrees Fahr.

The Carson blotter test is essentially a duplication on a small scale of the action of a plasterer when spreading plaster on a wall. The wall is represented by a sheet of blotting paper; the trowel by a metal spatula. The lime was mixed with enough water to make a good plastering consistency and allowed to soak over night. After soaking for 16 to 24 hours, the sample was spread out on the blotter with the spatula and its working qualities noted. The more plastic samples work more easily and spread over a larger surface than the non-plastic ones. The Carson blotter test enables one to measure the rate of drying of the lime, and also the work required to spread the lime on the wall before it has dried. The Emley plasticimeter does the same thing but naturally the conclusions to be drawn from the blotter test depend more upon the individual operator.

Samples burned in the vacuum furnace at 1,200, 1,400, 1,600, 1,800, 2,000, 2,200 and 2,400 degrees Fahr. were compared with the four marble samples burned at atmospheric pressure. All the vacuum samples were completely calcined, all hydrated rapidly and their plasticity changed only very slowly as the temperature of burning was increased. There was not as much difference in plasticity between the 1,200 and 2,000 degrees Fahr. vacuum samples as there was between the 1,800 and 2,000 degrees Fahr. air-burned samples. While pointing out that the blotter test is only qualitative, it can be said that there was no vacuum-burned sample as poor in plasticity as the sample burned in air at 1,800 degrees Fahr.; in fact, the 2,000 degrees air-burned sample was probably not as good as the worst vacuum sample. The sample burned in air at 2,200 degrees was fairly plastic but not nearly so plastic as the best vacuum samples.

X-Ray Results

X-ray photographs were taken of all samples. Typical films are shown in Figures 2-6. All the CaO samples burned in a vacuum gave films identical with Fig. 2, although in the film for the sample burned at 1,200 a few extra lines showed up very weakly. All the hydrate samples from marble burned in a vacuum gave films identically like Fig. 4, although, analogous to the oxide, a few these same lines occurred as well as extra lines, very weak extra lines showed up on the sample burned at 1,200. In all the samples burned in air, these same lines occurred as well as extra lines, although for the samples burned at 2,200 the extra lines were very weak, and weaker for the precipitated carbonate sample (the plasticity here was higher) than for the marble. In every case, the intensity of these extra lines could be taken as a direct measure of the plasticity of the sample. (These lines were the same for samples burned at high and low temperatures, but for samples burned at the higher temperature the intensity was less.) The vacuum-burned samples (with the exception of the 1,200 degree sample) were more plastic than the air-burned samples and only with the 1,200 degrees sample did extra lines occur. The 2,200 degrees precipitated calcium carbonate sample was more plastic than the 2,200 degrees marble sample and the extra lines on the oxide and hydrate films for it were weaker. The plasticity of the 1,800 degrees and 2,000 degrees precipitated calcium carbonate were very similar, as were also the x-ray films; the plasticity of the 2,000 and 2,200 degrees marble were very similar, as were the x-ray films. In fact, by the intensity of these extra lines (i. e. lines not occurring on films for samples of the highest plasticity) we have a direct measure of the plasticity of the sample, qualitative if not quantitative.

The CaO samples burned in vacuum clearly gave the diffraction pattern of a face-centered cube. The pattern for this structure has the first nine lines grouped so as to form three repetitions of a "pair followed by a single line." (The formula for this structure is $d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$, where a is a constant and h, k, and l are whole numbers.) The tenth line, corresponding to the spacing $\frac{1}{\sqrt{26}}$ would be the first line of the next pair except that the second line of the pair would correspond to a spacing $\frac{1}{\sqrt{28}}$, which cannot exist. The sequence of "pair and one" is continued for three more groups, after which it is broken up again by missing lines.

The position of the lines and their intensities are given in Table II (v.s. = very strong; s = strong; m = medium; w = weak; v.w. = very weak). The method of calculating the spacings is as follows: The distance on the photograph from a reflection line to the central undeviated image divided by the distance from the powder to the photographic film gives 2Θ, twice the reflection angle of the x-ray beam, since the wave-length, λ, of the rays producing the powder reflection is known ($K_d = 0.710$) and $\sin \Theta$ can be calculated from this determination of $2\ \Theta$, the ratio of the planes producing each powder line to the order n of reflection $\frac{d_{hkl}}{n}$ is given by the following rearrangement of the classic equation

$$n\lambda = 2d_{hkl}\sin\Theta_n : \frac{d_{hkl}}{n} = \frac{\lambda}{2 \sin \Theta_n}; \frac{d_{hkl}}{n}$$

as given in column 2 of Table II.

Table II.

CaO films; Marble burned in a vacuum from 1400 degrees to 2400 degrees Fahr.

Intensity	Spacing of Planes in Angstroms Observed	Calculated	Indices of Form
s.	2.797	2.78	111
v.s.	2.42	2.39	010(2)
v.s	1.717	1.71	110(2)
s.	1.458	1.45	311
s.	1.397	1.39	111(2)
m.	1.210	1.19	200(2)
m.	1.109	1.13	411
s.	1.081	1.075	210(2)
s.	0.986	0.982	211(2)
m.	0.931	0.924	511
m.	0.855	0.850	220(2)
m.	0.816	0.822	530
m.	0.805	0.812	531

For definitely assigning a structure to these crystals, the observed data as given in Table II and the curves as constructed by Davey are used. An exact match for all the lines occurring on these films is found in the rhombohedral lattice at the axial ratio 2.45; the face-centered tetragonal lattice with axial ratio 1.00; and the body-centered tetragonal lattice with axial ratio 1.414, all of which are face-centered cubes. This is checked by a direct calculation of the density. For a cubic crystal, the density of a substance is given by

$$P = n \frac{M \times 1.649 \times 10^{-24}}{(d \text{ x } 10^{-8})^3}$$

where

P = density.

M = molecular weight of the substance; 1.649 x 10^{-24} is the mass in grams of one unit of molecular weight.

d = the side of the elementary cube (it is the distance in angstroms between the 100 planes in the crystal).

n = the number of points associated with a unit cube in the crystal lattice. n = 4 for the face-centered cubic lattice. P = 3.26 as compared with the value of 3.40 as given in the International Critical Tables and the value of 3.37 by the accepted x-ray measurements.

In a simple cubic space lattice, the representative points are arranged at the corners of a series of cubes. If the cube edge is of length a, it can be shown that the distance d between successive planes in the structure parallel to a face whose indices are (h, k, l) is given by

$$d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

Assuming by trial and error the value 4.79 Å for a and solving for d, gives the values in column 4 of Table II, which agree well with the experimental values. This value of a is in good agreement with the values found by previous experimenters. Thus we can assume that CaO samples from marble which gives the most plastic hydrates consist practically entirely of CaO crystals, face-centered cubic with a unit edge 4.79Å. (In reality, as accurate intensity measurements show, CaO is simple cubic with the Ca and O atoms on alternate corners. In the powder photographs, only the reflections from the Ca atoms are recorded and thus we get a face-centered cubic pattern.)

The position of the lines on the $Ca(OH)_2$ films from marble burned in a vacuum and their intensities are given in Table III. The method of calculating the spacings is the same as for the CaO films.

Table III

$Ca(OH)_2$ films; Marble burned in a vacuum—1400-2400 degrees Fahr.

Intensity	*Spacing of Planes*
s	4.975
m	3.14
v.s.	2.63
s	1.925
m	1.792
m	1.69
v.w.	1.562
m	1.485
m	1.457
m	1.315
v.w.	1.232
v.w.	1.215
v.w.	1.180
m	1.147
v.w.	1.127
w.	1.062
v.w.	1.042
w	1.03

Using the data as given above and the curves as constructed by Davey, a match is found in the triangular close-packed lattice of the hexagonal system at the axial ratio 1.40. The distance corresponding to the 10.0 planes is 3.14Å. This is the altitude of the equilateral triangle which forms the base of the unit prism. The side of the unit triangle is ⅔ times this distance. The density of the specimen is

$$P = n \frac{M \times 1.649 \times 10^{-24}}{\sqrt{\frac{3}{4}} \times \frac{c}{a} \; (a \times 10^{-8})^3}$$

where

P = density.

M = molecular weight of the substance; 1.649 × 10^{-24} is the mass in grams of one unit of molecular weight.

n = number of points associated with a unit prism; n = 1 for a triangular close-packed lattice.

a = side of the unit triangle.

$\frac{c}{a}$ = axial ratio.

P = 2.146, which is in fairly close agreement with the value 2.343 as given in the International Critical Tables and 2.31 by the accepted x-ray measurements.

This corresponds with the results of Levi, who found a = 3.25Å; c = 4.93; and $\frac{c}{a} = 1.40$. For a hexagonal structure, the distance d between successive planes in the structure, parallel to a face whose indices are (hkl) is given by

$$d^{hkl} = \frac{a}{\sqrt{\frac{4}{3}(h^2 + hk + k^2) + \left(\frac{l}{c}\right)^2}}$$

Owing to the large amount of calculation involved in checking up each line on the film, this was not done. It is not important for our purpose and the structure has been definitely determined by the curves of Davey and the check of the theoretical and actual density determinations. Thus, we can conclude that plastic hydrate samples from marble and calcium carbonate consist almost entirely of $Ca(OH)_2$ crystals with a hexagonal close-packed structure of axial ratio 1.40.

Analogous data for calcium carbonate are given in Table IV.

Table IV

Baker's analyzed calcium carbonate or pure marble.

Intensity	*Spacing of planes*
m	3.88
v.s.	3.06
v.w.	2.86
s	2.52
s	2.305
s	2.115
s	1.93
s	1.89
m	1.615
m	1.53
v.w.	1.48
m	1.45
v.w.	1.37
v.w.	1.345
w	1.31
w	1.26
w	1.245
w	1.187
m	1.165
m	1.055
w	1.019
w	0.992
w	0.970
w	0.949

A structure was not worked out for the calcium carbonate, for it was not essential for our purpose. However, its structure is well known; it belongs to the rhombohedral class of the hexagonal system with which these data agree.

Since extra lines occurred on the photographs of air-burned samples and not on the photographs of vacuum-burned samples, it was natural to search for a cause of these extra lines in something that was present at atmospheric pressure and not in a vacuum. The two natural things to suspect would be carbon dioxide and water vapor which would not be driven off as readily at atmospheric pressure as in a vacuum. This supposition was found to be correct. In all cases, the extra lines on the films from non-plastic samples, if oxide films, correspond to strong lines on hydroxide and carbonate films, and if hydroxide films, the extra lines corresponded to strong lines on the carbonate film. A tabulation of these extra lines is given in Table V for the CaO samples.

Table V

Extra lines occurring on CaO films from samples burned in air 1800° Fahr.

Marble			Calcium Carbonate		
Intensity	Spacing of Planes	Agrees with	Intensity	Spacing of Planes	Agrees with
s	5.00	$Ca(OH)_2$	s	4.97	$Ca(OH)_2$
v.w.	3.14	$Ca(OH)_2$	m	3.14	$Ca(OH)_2$
s	3.05	$CaCO_3$	m	3.05	$CaCO_3$
s	2.66	$Ca(OH)_2$	s	2.65	$Ca(OH)_2$
w	2.305	$CaCO_3$	v.w.	2.305	$CaCO_3$
w	2.11	$CaCO_3$	v.w.	2.11	$CaCO_3$
s	1.94	$Ca(OH)_2$	m	1.935	$Ca(OH)_2$
w	1.89	$CaCO_3$	m	1.81	$Ca(OH)_2$
m	1.815	$Ca(OH)_2$	v.s.	1.155	$Ca(OH)_2$
v.w.	1.156	$Ca(OH)_2$			
v.w.	1.050	$CaCO_3$			
2200 degrees Fahr.					
m	5.00	$Ca(OH)_2$	m	5.00	$Ca(OH)_2$
v.w.	3.14	$Ca(OH)_2$	m	3.14	$Ca(OH)_2$
m	3.05	$CaCO_3$	m	2.65	$Ca(OH)_2$
m	2.65	$Ca(OH)_2$	w	1.93	$Ca(OH)_2$
v.w.	2.29	$CaCO_3$	w	1.82	$Ca(OH)_2$
v.w.	2.11	$CaCO_3$	v.w.	1.155	$Ca(OH)_2$
m	1.935	$Ca(OH)_2$			
w	1.81	$Ca(OH)_2$			
v.w.	1.15	$Ca(OH)_2$			

Judging from the intensities of the lines, a fairly large percentage of both $CaCO_3$ and $Ca(OH)_2$ was present in the samples of lowest plasticity. In the samples of highest plasticity (precipitated $CaCO_3$ burned at 2200 degrees Fahr.) no carbonate lines were present. The $Ca(OH)_2$ present was apparently not due to contamination afterwards, as the samples were treated as nearly like the vacuum burned samples as possible and there was no contamination there. It was probably due to water not given off at the temperature of burning.

A tabulation of the extra lines occurring on the $Ca(OH)_2$ films is given in Table VI.

Table VI

Extra lines occurring on $Ca(OH)_2$ films from samples burned in air 1800 degrees Fahr.

Marble			Calcium Carbonate		
Intensity	Spacing of Planes	Agrees with	Intensity	Spacing of Planes	Agrees with
v.w.	3.03	$CaCO_3$	s	3.05	$CaCO_3$
m	2.49	$CaCO_3$	w	2.51	$CaCO_3$
m	2.29	$CaCO_3$	w	2.32	$CaCO_3$
m	2.10	$CaCO_3$	w	2.11	$CaCO_3$
m	1.88	$CaCO_3$	w	1.895	$CaCO_3$
v.w.	1.615	$CaCO_3$			
2200 degrees Fahr.					
w	3.01	$CaCO_3$	No extra lines		
v.w.	2.49	$CaCO_3$			
v.w.	2.29	$CaCO_3$			

Here, again, there were no extra lines on the film of highest plasticity. However, in a film of $Ca(OH)_2$ from precipitated $CaCO_3$ burned in air at 2200 degrees Fahr. and exposed for twice as long as the films were ordinarily exposed, extra carbonate lines did show up weakly. Thus, there is some carbonate present but in smaller amount than for the samples of lower plasticity. It should also be noted that in some cases the position of lines on the $Ca(OH)_2$ and $CaCO_3$ films, or on the CaO films, are identical and thus would not be tabulated in Tables V and VI.

The CaO and $Ca(OH)_2$ films from marble burned in air at 2000 degrees Fahr. were almost identically

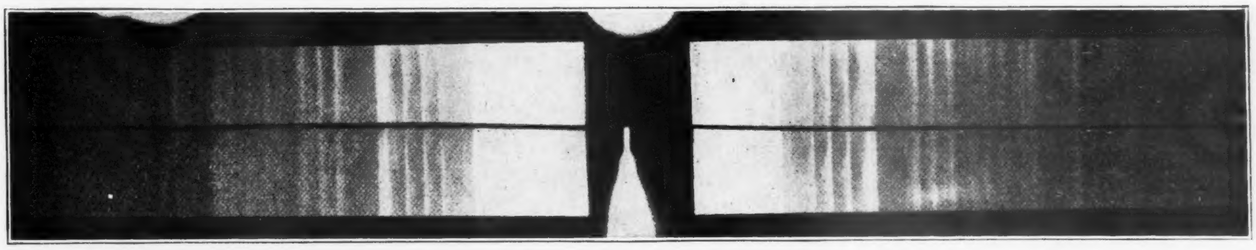


Figure 6—C. P. $CaCO_3$

like the analogous films for samples burned at 2200 degrees Fahr. The CaO and $Ca(OH)_2$ films from precipitated calcium carbonate burned in air at 2000 degrees Fahr. were almost identical with analogous films for the sample burned at 1800 degrees Fahr.; so no data are given for these films.

Discussion of Results

It is interesting to speculate as to whether or not the $Ca(OH)_2$ and $CaCO_3$ are the cause of the decrease in plasticity of the lime or simply an accompanying phenonemon. It is hard to see why $Ca(OH)_2$ present in lime should decrease the plasticity when it is all converted into $Ca(OH)_2$ before the plasticity is tested. However, the $Ca(OH)_2$ already present might act as centers of crystallization and thus give rise to larger crystals which would be less plastic. Since only $Ca(OH)_2$ and not $CaCO_3$ is present in appreciable amount in the more plastic air-burned samples, it may be only the $CaCO_3$ present which causes a decrease in plasticity. It is easy to see how $CaCO_3$ present in fairly large amount would decrease the plasticity by decreasing the amount of oxide present. By this it is not meant that a simple admixture of calcium carbonate would materially decrease the plasticity but if the calcium carbonate coated some of the grains of oxide and slowed down the rate of hydration, the plasticity would be decreased. X-ray photographs of commercial samples show that calcium carbonate is always present in samples of low plasticity. (In the application of x-rays to lime plastitcity we have a possible application to factory control. An x-ray photograph could be taken for each run and compared to a standard film for a sample of high plastitcity. Extra lines would indicate a decrease in plasticity and the intensity of these extra lines would be a direct measure of this decrease.) The presence of $Ca(OH)_2$ and $CaCO_3$ offers no explanation of the low plasticity of overburned lime but here the additional complication of sintering enters in. Due to the lack of a suitable furnace, no tests were made with over-burned lime.

Summary

Marble and precipitated calcium carbonate were burned in air at 1800, 2000 and 2200 degrees Fahr. and marble in a vacuum furnace at temperatures from 1200 to 2400 degrees Fahr. in steps of 200 degrees. The plasticity of all these samples is measured and x-ray powder photographs of the oxides and hydrates taken. The samples burned in a vacuum were found to be more plastic than the samples burned in air. The CaO samples which give a plastic hydrate give a face-centered cubic pattern with unit edge 4.79Å; the plastic hydrates give a hexagonal pattern with an axial ratio 1.40. The patterns of the less plastic samples are complicated by additional lines corresponding, if CaO films, to strong lines of the $Ca(OH)_2$ and $CaCO_3$ films, and if $Ca(OH)_2$ films, to strong lines of the $CaCO_3$ film. In every case, the intensity of these extra lines can be taken as a direct measure of the plasticity of the sample; these lines are the same for samples burned at high and low temperatures, but for samples burned at the higher temperatures the intensity is less. Experiments were not carried out with over-burned samples. It is interesting to speculate as to whether or not the $Ca(OH)_2$ and $CaCO_3$ are the cause of the decrease in plasticity of the lime or simply an accompanying phenomenon. It is hard to see why $Ca(OH)_2$ present in lime should decrease the plasticity when it is all converted into $Ca(OH)_2$ before the plasticity is tested. However, the $Ca(OH)_2$ already present might act as centers of crystallization and thus give rise to larger crystals which would be less plastic. Since only $Ca(OH)_2$ and not $CaCO_3$ is present in appreciable amount in the more plastic air-burned samples, it may be only the $CaCO_3$ present which causes a decrease in plasticity. It is easy to see how $CaCO_3$ present in fairly large amount would decrease the plasticity by decreasing the amount of oxide present. By this it is not meant that a simple admixture of $CaCO_3$ would materially decrease the plasticity but if the $CaCO_3$ coated some of the grains of oxide and slowed down the rate of hydration, the plasticity would be decreased. X-ray photographs of commercial samples show that $CaCO_3$ is always present in samples of low plasticity. The presence of $Ca(OH)_2$ and $CaCO_3$ offer no explanations of the low plasticity of overburned lime but here the additional complications of sintering enter in.

Ancient Slag Discovered

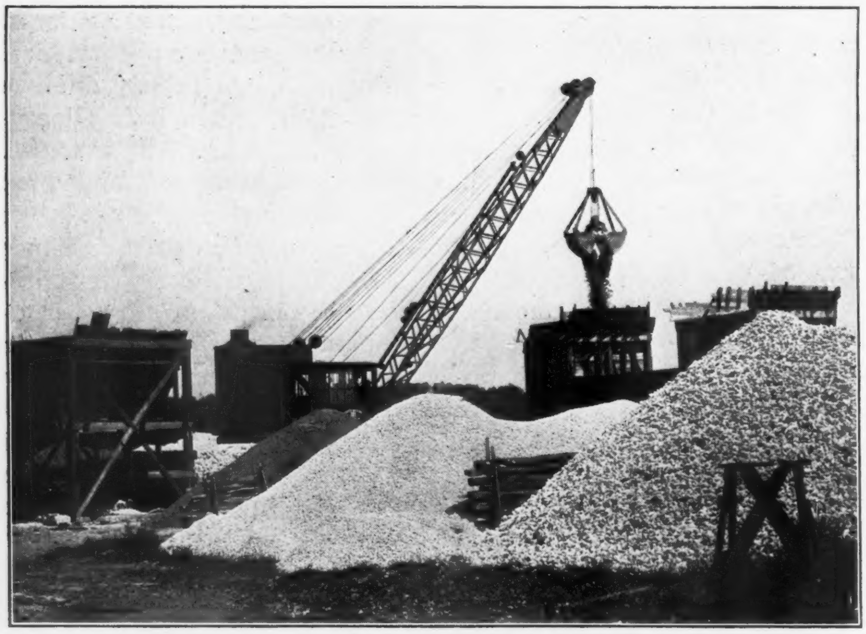
Slag residue left by the Romans in the early centuries has been discovered in huge quantities in France and is being used in the French iron and steel industry with remarkable success.

The Clamshell Bucket

It is a long way, as regards years, from the days of Alexander the Great's siege operations to the present industrial day, yet the modern sand and gravel or crushed stone plant owes much to the ingenuity which certain Greek engineers, of that distant day, showed in the construction of siege machinery. One of these engines was the forefather of the modern clamshell bucket. It was crude in design but the idea was a pincers operated from the end of a swinging boom, the closing action of the pincers being applied in much the same manner as the action of the modern clamshell bucket. This gigantic pincers, swung against the coping of an enemy's embattlement, would seize a huge stone and tear it from its place in the wall.

From this ancient siege engine was developed the crane, and later the bucket, but the bucket was for long regarded as just something to grab with, in many respects like the original gigantic pincers. The buckets were used as accessories to cranes and only gradually did they develop into a distinctive product line. The bucket as we know it today is comparatively modern.

Clamshell Used in Excavating



Clamshell Used in Storage

In its favor, it can be noted that there are many more uses for clamshell buckets than for any other type of digging or lifting equipment. The steam shovel is only good for digging; the dredging barge with rotating belt of scoops is only of use for this one purpose; conveyor belts for rehandling materials have but a limited use. In clamshell buckets the addition of removable teeth changes it from a rehandling instrument to a powerful digging tool.

These buckets are made today for a variety of purposes, in sizes and weights to meet the particular requirements of the field in which it is to be used. There are types for use in handling material from cars, barges or piles; there are buckets fitted with detachable teeth that will dig into clay or packed gravel; and there are light weight buckets for fast work in easy material.

There was a time when gravel pits were dug by hand, the material hauled up in small buckets and then rehandled with shovels two or three times before it reached its point of consumption. Today a clamshell bucket scoops up the material, working at any depth, and empties its load into waiting cars or hoppers.

In the building construction field, clamshell buckets have often proved their value. Recently when excavating for a large office building these buckets were used to advantage. The ground consisted of a stratum of fine, close-packed sand that acted much like quicksand. Therefore, careful timbering was necessary to prevent the walls of the excavation from crumbling, and to guard against damaging the foundation of nearby buildings. The cross bracing made it impossible for a bucket to get side swing. It was a case of a straight drop, and then digging in. Four buckets were used on this job, emptying into hoppers which fed auto trucks.

These buckets have also been used successfully for dredging purposes. The increased tonnage of rivers resulted in an urgent need for deeper channels. To obtain this each channel was dredged until the required depth was obtained. At first the sand and gravel, which was taken up from the bottom of the river, was dumped in another part of the stream or used to fill up the swampy or low sections along the river front. However, about this time the demand for sand and gravel, for use in concrete construction work, was rapidly growing, and the dredgers found that there was profit in selling this material which was formerly only a burden to be gotten rid of.

Clamshell buckets are more widely used in the United States than elsewhere but even in this country many of its uses are still in their infancy and await a better understanding of the possibilities of this equipment. This does not mean that they are not known in other parts of the world. Today, these buckets are in use all over the world; wherever men have work to do that necessitates the handling of loose materials, there will be found these buckets on the job.

INTIMATE NEWS OF MEN AND PLANTS

Duff A. Abrams Goes With International Cement

The International Cement Corporation announces the appointment of Professor Duff A. Abrams as Director of Research. It also announces plans for the construction of a Research Laboratory, which will be under Mr. Abrams' charge.

Mr. Abrams has made the study of structural materials his life's work. All who use concrete are the beneficiaries of the remarkable work which he has done. While attending the University of Illinois, from which he was graduated in 1905, Mr. Abrams spent much of his time in the field working with concrete. The first years after graduation were devoted to important construction projects as well as to experimental work with structural materials, primarily concrete.

The climax of the first decade of his career came in 1916, when he assumed direct charge of the Structural Materials Research Laboratory as a joint actiivty of the Lewis Institute and the Portland Cement Association. The work carried on under the direction of Mr. Abrams during the ensuing ten years ranks as one of the outstanding achievements in applied research in American industrial history. From July, 1926, to March, 1927, Mr. Abrams was Director of the Research Laboratory of the Portland Cement Association. Mr. Abrams has justly earned the right to be designated the premier authority on the use of concrete.

As Director of Research of the International Cement Corporation Mr. Abrams enters upon the third decade of his distinguished career. He will have unlimited scope for his endeavors. The organization of which he now becomes an honored part looks upon the manufacturer of cement through the same glasses that Mr. Abrams views its use. It has labored as unceasingly to improve the quality of its product as Mr. Abrams has labored to improve and develop the technique of its use. In addition, wide opportunity for service is afforded to Mr. Abrams in the fact that Lone Star Cement is being used in some of the most important construction projects throughout two continents, embracing all kinds of structural conditions and requirements.

And, finally, he is assured of the sympathetic cooperation of a corporation which realizes that the future growth of its business, as well as of the industry of which it is a part, rests squarely upon the quality of cement itself and upon the methods by which this highly technical product shall be made to serve, to constantly greater advantage, the growing needs of the construction industry.

The International Cement Corporation has ten subsidiary companies which operate eleven mills in North and South America. These mills have a combined annual capacity of 14,700,000 barrels of cement. The eight domestic mills of the International System serve the territory east of the Rocky Mountains, where their product is marketed under the brand name, "Lone Star" Cement.

River Products Company Secures James Baney

Mr. James Baney recently took the position of superintendent for the River Products Company, Iowa City, Iowa. At this plant on April 27th Mr. Monahan of the du Pont Company made a primary shot using 40 per cent N. G. dynamite, Cordeau and a small amount of 60 per cent gelatin. The results were all that could be expected, with no back break and a good back face.

Among the equipment used by this company are a 7½ and number 5 Allis-Chalmers and a 836 Universal Crusher. The Earth and Rock Equipment Company rebuilt an Erie Type B shovel for this plant.

Binney and Smith Company Purchase Talc Property

Binney and Smith Company recently purchased the property of the Alba Mineral Company at Kinsey, North Carolina. The talc from this mine at Kinsey is of a very high quality and by many considered the equal of French and Italian talc. The new company proposes to develop the property and have engaged the services of an engineer, Mr. J. W. Bailey, to undertake the work.

The Chicago offices of the Alpha Portland Cement Company were removed on April 16, 1927, to 165 West Wacker Drive.

Union Rock Adds To Storage

A report says that a permit was recently issued and work started on the construction of a $25,000 sand storage bunker at San Fernando Road, Lankershim, California, by the Union Rock Company.

F. A. Wilder Now Professor

Dr. Frank A. Wilder, formerly state geologist of Iowa, was recently appointed professor of Geology at Grinnell College, Grinnell, Iowa.

Dr. Wilder has been for the past twenty years president and superintendent of the Southern Gypsum Company, Roanoke, Virginia. This concern has been taken over by the Beaver Products Company, and Dr. Wilder will be retained as consulting geologist.

F. A. Wilder

Dr. Wilder was born in Ohio and is a graduate of Oberlin, with graduate work at Yale, Freiburg (Saxony), and Chicago, receiving his Ph. D. in geology from Chicago. He taught science in the high schools of Fort Dodge and later became assistant state geologist of Iowa, state geologist of North Dakota, professor of economic geology at the State University of Iowa, and state geologist of Iowa.

Poplar Ballast Company Enlarges Plant

The Poplar Ballast Company improved their plant at Poplar, Kentucky during 1926. The storage unit was rebuilt and enlarged. A new reduction crusher was added. A conveyor 150 feet centers and an elevator 50 feet centers were also added. A new 30 foot revolving screen with a 12 foot ⅜ inch opening dust jacket was installed. The plant is now equipped to produce limestone ballast and highway stone. J. F. Lewis is president, O. M. Lewis, vice president and secretary, and R. Ramey is treasurer.

Empire Gravel Producers Act on Freight Rates

A meeting of the members of the Empire Sand and Gravel Producers' Association was recently held in the Chamber of Commerce, Rochester, New York. The purpose of the meeting was to advance a movement to obtain the cooperation of Chambers of Commerce in New York state in the effort to obtain more uniform and equitable freight rates on sand and gravel in the state.

John F. Coyle, assistant manager of the Transportation Bureau of the Rochester Chamber of Commerce said that there was ample opportunity for fruitful work by the Association. This was evident when he pointed to the lack of uniformity and the high minimum rate on sand and gravel at various points in the state. Mr. Coyle also mentioned the fact that a general investigation of the situation is now being conducted by the Interstate Commerce Commission, and stated that it is expected that within a few months the Commission will make a report relative to the unification of rates.

The address by Mr. Coyle was followed by a general discussion of methods of obtaining the greater use of sand and gravel in construction. John G. Carpenter, president and general manager of the Madison Sand and Gravel Corporation and secretary and treasurer of the association, reported concerning activities of the association in the last few months. During his remarks Mr. Carpenter said that coal is the only commodity that furnishes greater volume of traffic to the railroads than sand and gravel, and that consumption of sand and gravel in the last three years has increased 15 per cent each year.

The next meeting of the Association will take place in May at the Madison Sand and Gravel Company at Hamilton, or with the Buffalo Gravel Corporation at Buffalo, it was announced at this meeting.

The following participated in the meeting: G. K. Smith, representing the Albany Gravel Company, and president of the association; D. Hyman, president of the Buffalo Gravel Company and vice-president of the association; John G. Carpenter, president and general manager of the Madison Sand and Gravel Company, and secretary and treasurer of the association; Weston Carroll, of J. E. Carroll Sand Company, Buffalo; W. J. Weinand, Jr., of East Aurora Sand and Gravel Corporation; Mr. Miller, Clean Sand Company, Boonville, N. Y.; Nathan Oaks, Nathan Oaks & Sons of Oaks Corners; Careton Oaks, of the same company; D. L. Evans, Rome Cast Stone Company, Inc., Rome; Edward Whaley, Lake Ontario Sand Company; L. M. Beattie, treasurer, Valley Sand and Gravel Company; John Taylor, president, Valley Sand and Gravel Company; Edward G. Stallman, secretary of the same company, and W. J. Gilmores, sales manager; H. L. Marsh, Consolidated Materials Corporation; Henry Marsh, Jr., of the Consolidated Materials Corporation; N. S. Snyder, Link Belt Company, Buffalo; John F. Coyle, assistant manager of the Rochester Chamber of Commerce Transportation Bureau; William A. Burdick, secretary of the Community Board.

New Sand Plant Organized at Cedar Rapids

Arrangements were recently completed for the organization of a new sand plant in Cedar Rapids, Iowa, under the name of the Cedar Rapids Sand and Materials Company, with a capital of $100,000. Mr. J. W. Kirkpatrick, J. M. Tallman and others are the incorporators. The new company will install a sand pumping plant on the Cedar River and will be served with a track connection by the Chicago, Rock Island and Pacific Railroad and it is expected to have the plant in operation by July 1st of this year.

The method which the new company will use will be the hydraulic system, using an 8 inch sand pump located on a floating barge equipped with electric motor. The sand will be pumped into sand screens and from there elevated into bins for loading into cars or trucks as desired.

Progress at Valley Forge

General grading for plant site of the Valley Forge Cement Company, West Conshohocken, Pennsylvania, was started the first week of January, 1927, and soon after excavation was commenced on the main buildings and machinery foundations. The first unit of the plant will be of approximately 2300 barrels per day capacity and equipment for the first unit will consist of the following:

One 48 inch x 60 inch jaw crusher for primary crushing, and a number 9 hammer mill for secondary crushing. Clinker and rock storage will be 242 feet in length and 80 feet wide. A 15 ton traveling crane will be installed with a 3 yard bucket. 7 feet-3 inch diameter by 42 feet-8 inch long compartment mills of the Solo type will be installed in both the wet and dry departments. The slurry will be handled from the wet mills by centrifugal pumps and from the finishing mills by the Fuller-Kinyon system.

Two 9 feet kilns with 11 feet-10 inch burning zones and 223 inches long will be installed. These kilns are of the Polysius Solo type and will be constructed by the Polysius Corporation. Clinker from each kiln will be discharged into automatic scales discharging directly into the clinker storage.

The coal mill equipment consists of a 5 feet-6 inch x 42 feet-0 inch Fuller-Lehigh indirect fired dryer and two 48 inch screen type Fuller-Lehigh pulverizer mills. The coal will be transported to the kiln bins by a Fuller-Kinyon system. Bailey type coal feeders will be used which will record the weight of coal fired. This, together with the clinker scales and the scales on the raw material, will give the operators a continuous record of material being handled. Power will be purchased from the Counties Gas & Electric Company. Switchboard and transformer equipment will be furnished by the Westinghouse Electric & Manufacturing Company, and all motors will be furnished by the General Electric Company.

Bakersfield Rock and Gravel Enlarges Plant

Expenditures of $25,000 in erecting an addition to its plant northeast of Bakersfield, California, have been announced by the Bakersfield Rock and Gravel Company. It is also planned to construct another $25,000 addition in the near future. When the expansion is completed, the Bakersfield Rock and Gravel Company will represent an investment of $200,000.

The company has installed an additional washing system, an extension conveyor system and a gas and power shovel. In addition modern showers and washrooms for the employees have been built. The new construction work to be done at an additional $25,000 expenditure will include the installation of a sand conveyor system and storage tanks for rotary clay, a by-product which hereafter will be saved.

Cornstalk Wallboard Plant Planned for Iowa

The Euromerican Cellulose Products Corporation of New York City will build a plant to manufacture wallboard from cornstalks somewhere in Iowa. Dr. John E. Jackson, research chemist, and C. W. Hussey, engineer, have spent considerable time inspecting sites in different parts of Iowa. Des Moines will probably be selected. The plant is expected to be in operation by October.

225,000 Tons of Rock Blasted

A tunnel blast was recently made at the quarry of the York Hill Trap Rock Quarry Company, Meriden, Connecticut, in which nearly thirteen tons of dynamite dislodged about 225,000 tons of trap rock.

The blasting and all the necessary preliminary work was supervised by the Hercules Powder Company. The dynamite was packed into two tunnels which had been drilled into the cliff in the form of the letter T. First a tunnel was drilled from the face of the cliff into its interior for a distance of about 60 feet, and from this tunnel two other tunnels branched out, forming a top for the T which measured approximately 100 feet. The work of drilling required about two months, while four days were required to pack the tunnels with the dynamite.

Among the engineers of the state highway department who viewed the blast were E. C. Welden, deputy highway commissioner, and division engineers Watrous of New London, R. W. Stevens of Hartford, and John Smith of Norwich.

Brownell Makes Changes in Thornton Plant

The Brownell Improvement Company at their Thornton, Illinois, plant has recently placed into service 4 number 95 Bucyrus shovels mounted on Osgood wheels and one Osgood shovel mounted on caterpillar tractors. Four new American steam locomotives have also been added. A water purifying plant manufactured by the Permutit Company, which is capable of purifying 13,000 gallons of water an hour, is being installed. A new pit is being opened on the other side of the road which runs alongside of the other pit. The area of this new pit is 4,000 feet long by 2,000 feet wide. A tunnel has been made from the old deposit under the road to the new deposit. It is estimated that there is sufficient limestone in the new deposit, after going down to a depth of 60 feet, which is the depth of the old pit, to keep the plant in operation about 40 years. Already much of the overburden has been removed by the use of the four Bucyrus shovels already noted.

The company is also extending the old deposit out. The intention seems to be, however, to work the new deposit to a depth equal to the old and then work the old deposit in 30 feet drops and then go over to the new deposit and bring it down to a similar depth. Tracks have been already installed from the old to the new deposit so that the four new locomotives can convey the stone from the new deposit to the elevators which carry it to the primary crusher.

More Gypsum in New Mexico

A new industry is in prospect for Alamogordo, New Mexico. Parties interested in large cement and other industries in Colorado have filed this week on nearly two townships of gypsum, known widely as the white sands, immediately west of Alamogordo. Names appearing on the filing list include O. P. Ady, H. E. Lindas, J. W. Ady, Jr., Jesse Lindas, H. P. Ady, John Lindas, Jr., Marta L. Pribble, and E. S. Edgar, all of whom are said to live in the Cripple Creek and Victor sections of Colorado.

The areas designated are in townships 15-16-17-18 south and range 7-8 east, covering the best part of the white sands. Chemical tests show that the white sand in this section runs from 93 to 97 per cent pure gypsum.

Joseph W. Ady, a member of this group and a leading mining engineer of Colorado, has made a careful investigation of local conditions. He and Dr. Lindas have investigated the fuel and power possibilities, and are discussing the matter of freight rates with Southern Pacific officials. A reasonable rate for power has been given by the new Texas-Louisiana Power Company, operating here in connection with the George E. Breece sawmill. If the new company's plans work out as they now anticipate, this 176,000 acre area, said to be the largest body of pure gypsum in the world, will be tapped with an electric railway and connected up with other commercial activities of this section.

Northern Indiana Company Cuts Costs Materially

The Northern Indiana Sand and Gravel Company electrified their plant and made some radical changes during 1926. Costs of production were cut materially.

A minimum of eight men and a maximum of twelve men produce 72 cars per day and the recent changes will soon increase this to 75 cars per day of twelve hours.

The equipment in use includes Morris and Worthington pumps; Universal nozzles; Armco pipe; Austin, Simplicity and Manganese Steel Forge Rolman screens, Austin crushers, Weller conveyor, G. E. motors, American Steel Dredge hull, etc.

Whitney Materials Company Completes New Plant

The Whitney Materials Company have just completed a new modern sand and gravel washing, screening and crushing plant at the foot of Twenty-first Avenue in Duluth, Minnesota. The new plant has a capacity of 1500 cubic yards per ten hour day and has many unusual features.

Non-Metallic Minerals Corp. Changes Name

The Non-Metallic Minerals Corporation, Los Angeles, California, recently changed its name to the Flynt Silica and Spar Company, of which Mr. A. F. Flynt is president and Mr. E. B. Dunning, secretary and treasurer. This company has also extended its plant, having put in service a Hardinge pebble mill, a 6x16 inch Krupp pebble mill and a 6x60 inch rotary dryer. The latter machine can also be used for calcining and other purposes.

At the present time this company is capable of turning out approximately 150 tons of fine grinding per day, 95 per cent 200 mesh up to 350 mesh. A deposit of feldspar has also been purchased and it is the intention of this company to operate this deposit within a short time and putting it on the market. The grinding performed at the present time at this plant consists mostly of Feldspar, Silica, Hematite and Clay.

Another Cement Plant for South Africa

The White's South African Cement Company, Ltd., Ventersburg Road, Orange Free State, Union of South Africa, are planning to build a cement plant. They have acquired a deposit of limestone about three miles from Hankey in the Gamtoos River Valley and about 40 miles from Port Elizabeth. This limestone belt is well known and extends for some twenty miles but it has not been considered commercially feasible to work it in the past.

Gypsum Firm Charters Boats

The shipments of gypsum will soon be coming to the plant of the Atlantic Gypsum Products Company at Portsmouth, New Hampshire, and will continue weekly throughout the summer. Two Norwegian steamships, the Pluto and Gida, have been chartered for the runs between Walton, Nova Scotia, and Portsmouth. The ship will also deliver cargoes at New York. The first cargo for the Portsmouth plant is expected the last of the present month.

Vance Joins Union Rock

According to report R. L. Vance has been appointed assistant to the president of the Union Rock Company, Los Angeles, California. Mr. Vance has been engaged in the building materials industry for the past 17 years, through his activities in charge of sales and traffic of the California Portland Cement Company.

Callanan Makes Large Shot

An interesting shot was made at the quarries of the Callanan Road Improvement Company at South Bethlehem, New York, on Saturday, April 23. Approximately 110,000 pounds of du Pont dynamite were used of which 40,000 pounds were 50 per cent gelatin and the remainder Red Cross Extra 40 per cent. Cordeau-Bickford safety fuse was used. This was the largest shot made thus far by the Callanan Company. It produced in the neighborhood of 350,000 tons of rock.

A Shot That Produced 350,000 Tons of Stone

The shooting of this large amount of dynamite attracted considerable attention and the blast was witnessed by a large number of stone men and engineers. The quarry produces crushed limestone for use on state highway work and railroad ballast in the Capital District. The loading was started on the morning of Wednesday, April 20, and was completed on Friday evening. Connections were made on Saturday morning and the shot fired at noon.

There were 200 well drill holes averaging 60 feet in depth. The holes were arranged in three different rows and the distance from the face of the rock to the back line of the holes was 55 feet. The length of the face was 1000 feet. S. R. Russell, Senior Technical Expert in the Field of E. I. du Pont de Nemours & Company, supervised both the loading and the shooting. The Callanan quarries are one of the oldest quarries in the east.

Western Pit and Quarry Now Organized

We are informed that articles of incorporation have been filed in the county recorder's office for the Western Pit and Quarry company, Sioux City, Iowa, with $200,000 listed as its capital.

Hubert Everist, president of the Western Asphalt Paving corporation and vice president of the L. G. Everist company is president of the new corporation. Business of the new company will be the handling of sand, gravel and stone. Offices will be in Sioux City, Iowa, with the L. G. Everist company and the Western Asphalt Paving corporation.

The company will have control of production of sand and gravel at the Hawarden, Iowa and Sioux Falls, South Dakota sand pits and the stone quarry at Dell Rapids, South Dakota. It will be a subsidiary company of the other two business organizations. Other officers of the corporation are: N. P. Randic, vice president; H. C. Boswell, secretary and P. O. Pederson, treasurer.

New Arkansas Cement Plant

A report says that recently a representative of the American Portland Cement Company along with railroad men and construction engineers visited Foreman, Arkansas for the purpose of erecting a cement plant. The deal was finally closed by the purchasing of 80 acres of land.

The party of Frisco R. R. officials was composed of J. B. Hilton, St. Louis, industrial commissioner; H. M. Booth, Ft. Smith, assistant engineer, and J. G. Weaver, Ft. Smith, division freight agent. Other members of the party were Col. Leigh Hunt, president of the Hunt Engineering company, of Kansas City; George J. Trombold, industrial engineer from the same company; John P. Streepey, Little Rock, and James H. Williams, of Ashdown and counsel for the American Portland Cement Company.

L. L. Griffith, of Ann Arbor, Michigan, a mechanical engineer, J. B. Harbison, a representative of the O. B. Avery company, makers of construction equipment, and Clay Oxford, of New York also were in attendance.

Myers Company Expands

According to a report the Myers Sand and Gravel Company, Anderson, Indiana has acquired a tract of sixteen acres of land directly south of the Big Four tracks, at the intersection of the eastern and southern divisions of the Big Four, near the south yards, and will establish a large new gravel plant. Power gravel washers and other large machines will be installed at once.

It is the intention of the company to begin operation of the pit at once. The gravel will be worked to a depth of 35 feet. Linfield Myers, head of the company, states that the area of sixteen acres will eventually be a large lake 35 feet deep for the south section of the city, and when the gravel has been taken out a park may be created with the lake as an attraction. The company is spending several thousands of dollars in developing the new plant.

Cement Plant Purchases Site

A report says that the deed for a block of preperty, near the John Sevier yards at Knoxville, Tennessee, which will be the site of the million-dollar cement plant proposed by the Volunteer Portland Cement Company, has been filed for probate at the courthouse. The property was bought from Anna B. Armstrong for a consideration of $44,000, according to the transfer book. The Volunteer Company was organized some time ago through the efforts of Howell J. Davis and others. Mr. Davis is vice-president of the corporation.

Everett-Saxon Plant Damaged by Fire

According to a report a fire recently destroyed much valuable machinery and part of the buildings at the Ashcom Stone Quarry of the Everett-Saxon Company at Cumberland, Maryland. The back wall of the boiler room fell away, allowing the flames to escape. Through prompt action the fire was held to one part of the structure until the arrival of the Everett Fire Company.

The boiler room was burned, the motor room destroyed and the ties of about 60 feet of track were burned off. A motor was damaged beyond repair. The quarry had been extended and new additions built to it last winter.

Canadian Blue Talc Deposits To Be Developed

We are informed that the only known talc deposits in Canada, located a few miles southwest of Banff, Alberta, will be developed in the near future as a private company, financed by Toronto capital.

J. H. W. Bower Talks About Insulex

Recently J. H. W. Bower, constructing engineer for the Universal Gypsum and Lime Company, said in an address before the Building Owners' and Managers Association of New York that "the growth in the use of gypsum has been rather phenomenal during the last eight or nine years. In 1880, only about half a million dollars worth of gypsum was mined in the United States. By 1916 the yearly production had grown to about $8,000,000. During 1924, almost $43,000,000 worth of gypsum was sold throughout the country."

"Insulex" is one of the recent additions of gypsum products. It is formed by adding a mineral yeast to the gypsum and a product is formed which, when mixed into water, expands and produces a cellular gypsum containing thousands of dead air cells. The resulting product is a material which is fireproof, vermin-proof and decay-proof; which has a high insulating value and which may be used to prevent the passage of heat and sound.

"Insulex" in its present form is essentially a poured-in-place product and the material comes to the job in powder form, packed in strong, damp-proof paper sacks. When added to water and thoroughly mixed, it expands and is poured into place while still in its plastic state. A permanent set occurs in twenty to thirty minutes and even during zero weather there is a sufficient amount of heat generated to carry the material over the setting period before any frost action can harm it.

When expanding, the material follows the line of least resistance and will not distort or bulge forms. Thus if it is being poured into vertical spaces the expansion occurs upwards and if poured in horizontal surfaces the material when rising above the height desired can be screeded or straightened to the desired level.

The basic fireproof qualities pertaining to gypsum remain unchanged in "Insulex." In addition, the product, having a high degree of insulation value, not only protects the structural members which it encases but also prevents the passing of heat to what it surrounds. In a test made at one of the universities a 2 inch slab of "Insulex" when subjected to an average heat of 2000 degrees during a period of two hours, maintained an average temperature on the upper side of the slab of less than 300 degrees.

This material can be produced in various weights. Where only insulation is required and where it is not necessary to place any dependence on the product for structural strength, a very light material is available known as Number 12, which weighs 12 pounds to the cubic foot when fully expanded. Where a slightly stronger material is required or where it is desired to precast the material into different shapes, a Number 18 is obtainable. For floor fill work or roof deck insulation a 24 pound product is manufactured which has a considerable structural strength and also a high degree of insulation value. For special work a 30 pound and a 36 pound are manufactured.

New Welding Rod

A new line of high grade "dipped" welding rod is now obtainable from the Lincoln Electric Company. This "dipped" steel rod is the result of several years study in the Company's Research Laboratories and will be known as "Stable-Arc" welding rod and is a companion to the "Kathode" welding rod which has been sold by the same company for many years.

With this new rod it is possible to go to considerably larger diameters than has been customary in welding rods for metal electrode welding and is being carried in all sizes up to ½ inch.

It is claimed that this rod permits of much higher currents than has been used heretofore with the resulting greater speed. Not only does the greater heat give greater speed and less cost but also better penetration and a much smoother finished bead. In addition the greater heat obtainable by the higher current results in an annealing action which increases the ductility of the weld and gives a greater elongation.

A New Self-Loader

The hull of the new self-unloading limestone carrier for the Bradley Transportation Company was launched on April 9, at Lorain, Ohio. The vessel is being constructed in the American Shipbuilding Company yard, and will be the largest and most modern ship of its class in the world. This will be the second boat of that type to be put in service by the Bradley Company. The first was the T. W. Robinson which went into service in July, 1925, and has been operating successfully since that time.

In honor of the initiative and vision of the president of the Bradley Transportation Company, who has been given much of the credit for the remarkable progress in the more general application of electricity to Great Lakes vessels, the new carrier will be named the Carl D. Bradley. It will be a much larger boat than the T. W. Robinson, and the power plant will be of greater horsepower rating. The electrification of auxiliaries will also be more complete.

The electrical equipment for the boat, including the power plant, will be furnished by the General Electric Company. Electricity for operating the main propulsion motor and auxiliary motors will be furnished by a complete turbine-generator power plant normally rated 4200 shaft horsepower and having a maximum rating of 4800 shaft horsepower. This is the second application of turbine-electric drive to a bulk freighter, the first being made on the T. W. Robinson.

New Incorporations

Plattsburg Limestone Co., Plattsburg, N. Y.

Avoca Quarries Corp., Bedford, Ind. 2500 shares n.p.v.; $50,000 pfd. Quarry and mine stone. Andrew Zeigler, Ben Bridwell, Rollie A. Tindall, John Ogden.

McGill Corp., Greensburg, Pa. $5000. Sand. (H. H. Swaney, Beaver Falls, Pa.)

Central Mica Corp., Rocky Mount, Va. Will develop 150-acre mica deposit. Ryland Goode, Pres.; W. E. Woody, Sec.; H. N. Prillman.

Fort Sumner Sand & Gravel Co., Fort Sumner, N. M. $50,000. S. F. Sullenberger, Charles Nicholson, Roy S. Nelson, W. D. Burger, Amarillo, Tex.; O. B. Erickson, Fort Sumner, N. M.

Mineral Tone, Inc., Wynne-Claughton Bldg., Atlanta, Ga. $25,000. To develop natural mineral resources of Georgia, including kaolin and other clays, etc. Will establish plants in Atlanta and Calhoun, Ga.

Western Pit and Quarry Co., Sioux City, Iowa. $200,000. Pres., Hubert Everist, pres. of Western Asphalt Paving Corp., and v. pres. of L. G. Everist Co.; v. pres., N. P. Randic; sec., H. C. Boswell; treas., P. O. Pederson. Will have control of sand and gravel production at Hawarden, Ia., and Sioux Falls, S. D., sand pits, and Dell Rapids, S. D., stone quarry.

Sumter Lime Rock Co., Orlando, Fla. Fred S. Scott, Orlando; Charles S. Steward, E. Steward, Indian River City, Fla. $10,000.

Southern Gravel Co., Inc., Alexandria, La. $25,000. W. C. Easton, O. H. Lewis, Harry F. Bush.

Brookhurst Sand & Gravel Co., Asbury Park, N. J. $125,000. Edwin P. Longstreet.

Lensch Sand & Gravel Corp., Babylon, N. Y.

Valuable Research Program Offered by Mining Schools

Excellent oportunities for training in methods of scientific research along mining and metallurgical lines are afforded by a series of fellowships offered by a number of leading educational institutions for work in cooperation with the United States Bureau of Mines, Department of Commerce, covering the educational year 1927-28. Students holding these research fellowships are assigned to assist in the solution of certain problems on which members of the technical staff of the Bureau of Mines are working, and the successful completion of their tasks makes them eligible for various degrees.

The Department of Mining and Metallurgy, College of Engineering, of the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, offers eight fellowships in mining and metallurgical research, for work in cooperation with the Pittsburgh experiment station of the Bureau of Mines and advisory boards representing the mining and metallurgical industries. Fellowships are open to graduates of colleges, universities and technical schools, properly qualified to undertake research investigations. Each fellowship carries a stipend of $750. Fellowship holders become candidates for the degree of Master of Science.

The Mackay School of Mines of the University of Nevada, Reno, offers one fellowship open to graduates of American mining colleges of recognized standing. The income of the fellowship is $750 per year. The holder will be assigned to research service with the staff of the Rare and Precious Metals Experiments Station of the Bureau of Mines.

Several fellowships, each having an annual net value of $720, are offered by the Department of Mining and Metallurgical Research, University of Utah, Salt Lake City. This department cooperates with the Intermountain Experiment Station of the Bureau of Mines.

Four fellowships are offered by the School of Mines and Metallurgy, University of Missouri, Rolla, Missouri. These fellowships are open to graduates who have the equivalent of a Bachelor of Science degree and have had the proper training in mining, metallurgy, or chemistry and who are qualified to undertake research work.

The School of Mines of the College of Engineering of the University of Alabama offers five fellowships in mining and metallurgical research for work in cooperation with the Southern Experiment Station of the Bureau of Mines at Tuscaloosa, Alabama. The fellowships, valued at $540 per year, are open to graduates of universities and engineering schools who have proper qualifications to undertake research and investigation. Fellowship holders become candidates for the degree of Master of Science. For investigation during the year 1927-28, fellows will study the beneficiation of low-grade bauxite ores, the beneficiation of phosphate rock, and float-and-sink treatment of Alabama coals.

The Arizona Bureau of Mines, a sub-division of the College of Mines and Engineering of the University of Arizona, Tucson, offers two fellowships in metallurgical and chemical research for work in cooperation with the Southwest Experiment Station of the Bureau of Mines. These fellowships are open to men who have obtained the equivalent of the Bachelor of Science degree from a recognized university or technical school, who have specialized in metallurgy or chemistry as undergraduates, and who are qualified to undertake research work.

The College of Mines of the University of Washington, Seattle, Washington, offers five fellowships for research in coal and non-metallic minerals for work in cooperation with the Northwest Experiment Station of the Bureau of Mines. The fellowships are open to graudates of universities and technical colleges who are properly qualified to undertake research investigations. The value of each fellowship is $720. For the year 1927-28, the following subjects have been selected for investigation: Beneficiation and washing of coal, including the application of ore dressing principles to the cleaning of coal; briquetting of low-grade coals and other problems in the utilization of coals of the Pacific Northwest; purification and washing of kaolins and ochres; problems in drying certain non-metallic minerals; efficiency studies in kiln-heating.

Natural Sodium Compounds and Borates in 1926

The production of sodium compounds, not including common salt, from natural salines and brines in this country in 1926, as indicated by sales or shipments by producers, amounted to 93,480 short tons, valued at $2,326,750, according to the United States Bureau of Mines, Department of Commerce. These figures show an increase of 28 per cent in quantity and 11 per cent in value as compared with 1925. They cover the output of sodium carbonate, sodium bicarbonate, sodium sulphate, trona, and borax.

Sodium carbonate (soda ash) and sodium bicarbonate were produced from Owens Lake by the Inyo Chemical Co., at Cartago, Calif., and the Natural Soda Products Co., at Keeler, Calif. Hydrated sodium carbonate (sal soda) was produced by the Wyoming Soda Products Co., at Green River, Sweetwater County, Wyoming. Trona, a double salt of sodium carbonate and sodium bicarbonate, was produced by the Natural Soda Products Co., Keeler, the Inyo Chemical Co., Cartago, and by the American Potash and Chemical Co. (successor to the American Trona Corp.), at Trona, Calif. The total sales of sodium carbonates in 1926 amounted to 56,750 tons, valued at $1,154,840, an increase of 24 per cent in quantity and 25 per cent in value.

Sodium sulphate (salt cake) was produced at Clarkdale (P. O. Camp Verde), Yavapai County, Ariz., by the Sodium Products Corporation (successor to the Western Chemicals, Inc.); at Wabuska, Nev., by the American Sodium Co. (successor to the Nevada Sodium Co.), and at Monse, Washington, by the Naso Chemical Co. Hydrated sodium sulphate (Glauber's salt) was produced at Casper, Wyoming, by D. W. Gill. The sales of sodium sulphate in 1926, comprising natural salt cake and Glauber's salt, were 19,620 tons, valued at $166,800, about double the output of 1925.

The boron minerals shipped in 1926 amounted to 115,970 tons, an increase of 2 per cent. The value was $3,128,110. These include borax (sodium borate) produced from natural brines at the plants of the American Potash & Chemical Co., Trona, and the Burnham Chemical Co., Westend, California, and colemanite (calcium borate) mined at Death Valley Junction, California, by the Pacific Coast Borax Co.; at Shoshone, California, by C. M. Rasor; and at Las Vegas, Nevada, by the Westend Chemical Co.

Republic Truck Appoints

The Republic Truck Sales Corporation has expanded its territorial sales organization by the creation of a Northwest Zone Manager and Southwest Zone Manager, for the supervision of sales in those states lying west of the Rocky Mountains, as well as in British Columbia.

Mr. R. H. Spencer, of Los Angeles, has been named Southwest Zone Manager and Mr. T. M. House, has been appointed Northwest Zone Manager. Mr. Spencer's territory will include the states of California, Arizona, New Mexico, and Nevada, while that of Mr. House covers the states of Washington, Oregon, Idaho, Montana, Utah and Wyoming, and the province of British Columbia.

A Small Northwest Used to Advantage

Some years ago it was thought that only the large machine was suitable for stripping and removing the tough layer that covers the average deposit of limestone. However, The Indiana Limestone Company, of Bedford, Indiana, has not only proven the ability of a 1 cubic yard Northwest but has done things with it that would be almost impossible with a larger machine.

At the McMillan-Saunders Quarry, (Old Reed Hole), Mr. A. E. Dickinson, president of the Indiana Limestone Company, and Mr. Nelson Joiner, vice-president in charge of quarry operations, have installed a Northwest for stripping. This machine is handling discolored and unsuitable stone. The overburden is approximately 50 feet deep and must be removed in two shifts. In order to do this the machine is moved from one lift to the other. This is done by taking the machine apart. The boom is removed, the rotating base is taken off and the crawler base is placed on the new level. Then the rotating base and boom are replaced and work begins anew. The entire change, including dismantling and reconstruction, is accomplished in only 3 hours.

Mr. George Reed, quarry superintendent, explained that they had started using a core-drill ahead of the shovel but the capacity of the Northwest was too great for it and the drill now works in two shifts. It is the plan to have another drill and keep them both busy.

In order to save powder cost, the rock was not shot any more than necessary to handle it. This in many cases made the digging hard. In spite of this, however, cables lasted thirty days. The maximum output of one day of ten hours was 120 skips of six cubic yards each, and in a period of five months the Northwest moved 40,000 cubic yards of material.


Northwest Shovel Stripping Overburden

Mr. A. R. Amos has returned to the Geo. D. Whitcomb Company. He is attached to the New York office, working directly under Mr. W. A. Smethurst, and is now permanently located at 1014 Harrison Building, Philadelphia, Pennsylvania.

Electric Detonator Gets Into Movies

The story of the electric detonator is depicted in a new educational motion-picture film just completed by the United States Bureau of Mines, Department of Commerce, in cooperation with one of the large explosives manufacturing concerns. The film shows in graphic detail the methods of manufacture and use of this modern and highly practical device for the firing of explosives.

The first scenes of the film give a general view of a large eastern plant devoted to the manufacture, assembling and testing of electric detonators. The processes of making the small metal shells which hold the detonating charge are first depicted. An idea of the special precautions that must be taken in the manufacture of explosives is given in a scene showing the storage under water of the fulminate of mercury, which comprises the main constituent of the detonating charge. The extreme care exercised in the operations of drying, screening and mixing the fulminate of mercury is emphasized in a series of views. The next process shown is the loading of the shells, the operation being performed within a metal case by an operator who, to insure his safety, stands outside. Animated photography is employed to explain minutely the methods used in charging the shells.

The waterproofing of the detonator, by sealing with molten sulphur, is shown. Another series of views illustrates the methods by which the completed detonator is tested in the laboratory, every detonator being subjected to the x-ray to determine if it is properly adjusted.

"The Story of the Electric Detonator" is the latest of a series of approximately 50 educational motion-picture films prepared by the Bureau of Mines and cooperating agencies for the purpose of visualizing different phases of the mineral industries of the United States. This film is now available for exhibition by schools, churches, clubs, civic bodies and other organizations. No charge is made for the loan of the film, the exhibitor being asked only to defray transportation charges.

Westinghouse Appoints

The Westinghouse Electric and Manufacturing Company announced recently the appointment of Mr. J. P. Alexander as Boston manager in charge of all sales and service in New England. During the twenty years that he has been associated with Westinghouse Mr. Alexander has become a prominent figure in the electrical industry in New England and has gained a wide experience which makes him particularly fitted for the responsibilities of his new position.

Mr. George H. Cox, who has been New England manager for the past eight years, has been appointed sales manager at the South Philadelphia Westinghouse Works in charge of the sales of all products manufactured at that plant, including steam turbines, condensers, Diesel engines, etc.

Arcofrax Alumina Brick

The General Refractories Company has issued a folder describing the services of Arcofrax high alumina brick in four kilns at a cement plant. Photographs are shown of the hot zone of one of the kilns after the lining had been in use 12 months or more of actual operating service.

It is stated that the entire of one of the kilns was in such good condition that it would have run longer. A copy of the original record of the four kilns gives the date when they were lined and date of each shut down and total length of service, is recorded.

New Refractory Method

Botfield Refractories Company has developed a method of maintenance that makes it easy to keep refractory construction in good condition through periodic and systemic maintenance.

In this method of refractory maintenance, three major elements are employed. They are the Adamant gun, Adachrome and Adamant fire brick cement. The gun is used for blowing protective coatings on brickwork in the form of pre-mixture of Adachrome (or other refractory materials), employing Adamant cement as a binder.

By this new method, linings can be returned to good condition whenever the equipment is out of service for a short time. Sometimes, the repairs can be made without interrupting the operation of the equipment. Cracks, crevices, joints and brick pores can be filled up, quickly and efficiently. Burned-out sections and depressions can be patched. Walls can be maintained at their original thickness, with a smooth uniform surface presented to the attack of flame and other destructive elements encountered in operation.

Weighing less than four pounds, the gun requires only one man for operation. It uses air or steam at 50 lbs. pressure or more. As air is more satisfactory in results, its use is recommended wherever possible. The operator simply connects the air line to the ½-inch standard pipe thread opening on the globe valve of the gun, spraying the pre-mixture smoothly and evenly on the structure.

Westinghouse Makes McLellan General Manager

Ross L. McLellan, formerly managing director of Cia. Westinghouse Electric Internacional, South America, has been appointed general manager of the Westinghouse International Company with headquarters in New York. Mr. McLellan, whose appointment was effective April 1st, arrived in New York recently from Buenos Aires and immediately assumed his new position.

Mr. McLellan was graduated from Purdue University with a degree in electrical engineering in 1907. He joined the Westinghouse forces in 1915 in Chicago as a salesman in railway work. In 1920, he joined the staff of Mr. F. H. Shepard, director of heavy traction, and 1921 went to Santiago, Chile, where he contracted on behalf of the Westinghouse Company for the electrification of the Chilian State Railways. In 1922 he represented the company in important negotiations with the government owned railways of Brazil, and in 1923 was sent to Europe, also in connection with railway electrification.

In 1924 he was made Managing Director of the Compania Westinghouse Electric Internacional, South America, a subsidiary of the Westinghouse Electric International Company operating in the Argentine Republic, Uruguay and Paraguay with headquarters in Buenos Aires, which post he held until his appointment as general manager of the Westinghouse Electric International Company.

Production of Potash in 1926

Potash produced in the United States in 1926 amounted to 46,324 short tons of crude potash salts containing 23,366 short tons of potash (K_2O), according to the United States Bureau of Mines, Department of Commerce. Sales by producers amounted to 51,369 tons of crude potash containing 25,060 tons of K_2O. The potash materials of domestic origin, sold by producers in 1926, were valued at $1,083,064 f.o.b. plants. About 26,000 tons of crude potash, with an available content of 9,000 tons of K_2O, remained in producer's stocks December 31, 1926. The production was chiefly from natural brines in California and distillery residue from molasses in Maryland. Small amounts were also obtained from steel plant dust in Pennsylvania, alunite in Utah, and glauconite in Delaware.

Fuller-Lehigh Line

The Fuller-Lehigh Company, one of the Babcock and Wilcox Company's organizations, took over on April 1st that portion of the business of the Bailey Meter Company pertaining to pulverized coal feeders, burners and water-cooled furnace walls. Grouping this equipment with the pulverizing mills, dryers, conveying systems, feeders and burners now gives the Fuller-Lehigh Company complete equipment not only of pulverized coal apparatus from the preparation plant to the furnace but for the construction of the furnace as well. This company will complete contracts for furnace walls and other similar equipment now on order with the Bailey Meter Company. E. G. Bailey is president and E. J. Billings vice president in charge of sales. The engineering staff includes J. B. Gaffney, chief engineer, and others.

The Philadelphia district offices of Combustion Engineering Corporation, Heine Boiler Company and Ladd Water Tube Boiler Company have been consolidated at 807 Bankers Trust Building, Philadelphia, Pennsylvania.

Equipment for Power Plants Issued by Worthington

"Equipment for Power Plants" is the title of bulletin Number HO 1900 recently issued by the Worthington Pump and Machinery Corporation. This bulletin is divided into sections, each dealing with apparatus manufactured by this company and discussed by means of text and illustrations.

The first section deals with steam condensers. In this classification two-stage rotative dry-vacuum pumps, hydraulic vacuum pumps, and steam-air ejectors are described. Centrifugal pumps, as used in power plants for boiler feeding; for circulating water through condensers; for supplying water for operating hydraulic air ejectors and similar work are the subject of the next section.

The design of the various types and where each can be used to best advantage are noted. Steam driven and power driven reciprocating pumps and rotary pumps are next discussed. Other sections discuss feed-water heaters, deep-well pumps, air compressors, diesel oil engines, gas engines and water and oil meters. The bulletin is well illustrated and contains practical information for power plants and consulting engineers as well as others interested in power plant problems.

R. D. Malm Sent to Chicago

The Lincoln Electric Company announces the appointment of Royal D. Malm as western district sales manager, with headquarters at Chicago. Mr. Malm is an engineering graduate from Case School of Applied Science, Cleveland, Ohio, class of 1912. For four years after leaving school he was engaged in construction engineering and then became identified with the Elyria Iron and Steel Company. Later he went with the Standard Welding Division of the Standard Parts Corporation as General Superintendent. For the past year Mr. Malm has had charge of Lincoln sales in the automotive industries with headquarters in Detroit.

Chain Belt Company Opens New Office

The Chain Belt Company has recently opened an office in Birmingham at 720 Brown Marx Building to handle the sale of Rex Chain and Conveying Systems in the State of Alabama. Mr. S. L. Morrow is in charge of the new office. Mr. Morrow has had many years of experience in the chain and engineering business, and is very well known in the Birmingham district.

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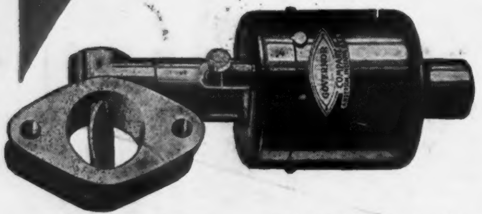

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